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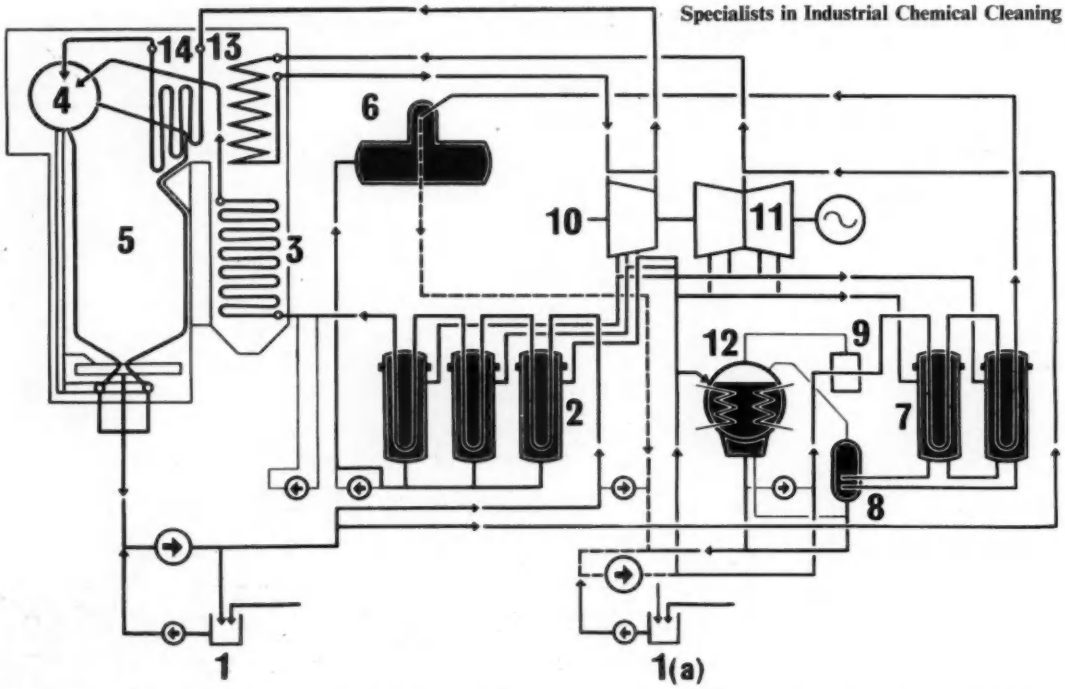

This diagram shows a typical circuit for acid cleaning solutions in natural circulation boilers. Chemicals are introduced through a mixing tank (1). In one circuit fluids pass through the water sides of the feed heaters (2) and into the economiser (3), the drum (4), and down through the wall tubes and headers (5). In this same circuit, the medium by-passes the low pressure turbine (11) and goes through the re-heater (13), then by-passes the high pressure turbine (10) and returns through the superheater (14) into the drum. In the other circuit the solution flows from the mixing tank (1a) through the feed water heaters (7) to the deaerator (6) and back. Chemicals are also flowing to the condenser (12) and back, through the heater steam sides (2 and 7) and the condenser flash vessel (8).

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

DECEMBER 1961

VOLUME 76. No. 12

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Engineering and BOILER HOUSE REVIEW

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INDUSTRIAL ENGINEERING RESEARCH

IN his presidential address to the Institution of Mechanical Engineers recently, Sir Kenneth Hague discussed the co-ordination of research. As chairman of Babcock and Wilcox Ltd., he considers the whole question of research in terms of its application and value to the user of it.

At the beginning of his address, Sir Kenneth said that the lack of scientific and technical manpower is generally recognised as one of the most urgent national problems of the day. The question, therefore, naturally arises: is the scientific and technical manpower at present available being utilised in the most effective and efficient manner ? Probably most engineers of long experience would agree that it is not. Research and development activities must, of necessity, have a first call on scientific manpower if this country is to retain its industrial position in the world, and, therefore, it would seem desirable once again to consider whether co-ordination of engineering research can be improved. Unless this problem is kept constantly under review, there is the grave danger that an important percentage of our available scientific manpower is being wasted as a result of duplication of effort and general lack of co-ordination in research.

Whilst it may be true to say that before the 1939-45 war the need for scientific research was not generally recognised, this is certainly not now the case. Today, most industrial concerns are interested to the extent that they either carry out some form of research themselves, or through one or more of the Research Associations to which they give their support. In discussing the programme of a works research department, for example, Sir Kenneth remarked: " There is little doubt that frequently items are included in a programme of research because they entail the kind of work which certain research workers would themselves like to do, whereas, careful consideration of the programme might show that there is important work which has not been included or not been given the necessary priority." He regarded the development of such a situation as a waste of trained scientific manpower, a waste of financial resources, and even more important still, not fulfilling the requirements for which the department was set up. Industrial research, more especially research within industry, should be directed research, directed to foreseen useful ends. Research workers with a compelling urge to do researches that particularly interest themselves are thus ill-placed in the laboratories of industrial firms.

Sir Kenneth also discussed co-ordination of research between universities and industry. On that subject, he pointed out: " It must be borne in mind that the first responsibility of a university is educational, so that the facilities in buildings, equipment and manpower which can be set aside wholly for the purpose of industrial research are naturally limited." Nevertheless, " in spite of many difficulties," he was convinced that better use could be made of the facilities available at universities, with mutual advantages, and here again it would result in the more efficient use of available scientific manpower.

When dealing with the question of research in universities, Sir Kenneth referred to the general question of training men for work in engineering research and said that he was of the opinion that even graduates who have a natural aptitude and strong desire to enter into the field of research might be well advised to devote a year or two to gaining practical experience as soon as possible after leaving their university, thereby qualifying themselves to be more effective research workers—assuming, of course, that they have not had a chance to obtain any practical experience prior to entering the university. Much of what Sir Kenneth had to say centred around his own experience in present-day industry, and directly concerned the close relationship between research and engineering development. He made some forceful remarks concerning the need for a certain degree of secrecy in development work. At the level of company research it is inevitable that any new invention, or ideas that appear to be new only to the thinker or research worker, will be developed secretly so that it can be ascertained whether or not commercial advantage can be gained as a result of such development. The days when a new idea, on which much time and energy had been spent, could be patented with the comfortable feeling on the part of the patentee that his work was protected for at least a period which would enable him to use it exclusively to his own advantage are largely over. As a result, it is often profitable to develop a new idea and put it into practice without heralding it with a patent application which enables competitors and even customers to apply all their efforts to circumvent the patent instead of working on their own original ideas.

Under present-day conditions—with Government agencies and their various contacts in industry, with the nationalised industries, and with some foreign countries who pay little or no regard to international undertakings regarding patent rights—it is doubtful whether it is worth the trouble and expense involved in taking out a patent on a new development. Most likely it will be found to be far more profitable to develop and exploit new ideas than to apply for a patent for which the advantage gained is so ambiguous that it is theoretically useless and certainly would not justify the trouble and expense of legal action if it were infringed. Sir Kenneth said that he, of course, realised that in certain sections of the engineering industry patent rights can be retained successfully and are invaluable to the patentee firms, but, nevertheless, the problem of adequate patent precaution appears to be increasingly difficult to solve. For these reasons it is obvious that any individual company will be willing to co-operate on all the research and development items which they have on their programmes. Only when they realise that their ideas are not exclusive and that they will gain more by co-operation with others, do they enter into the next field of activity, which is, of course, the industrial research association.

Points and Pointers

SECOND NEW POWER STATION FOR YORKSHIRE

The Central Electricity Generating Board recently received consent from the Minister of Power for the construction of the second of the two large new power stations it is planned to build in the West Riding of Yorkshire. Consent for the first (at Ferrybridge) was given last August. The new station will be situated on the River Aire at Eggborough, some six miles east of Ferrybridge. The main plant will comprise four turbo-generators, each of 500-MW installed capacity, and four boilers, each with an evaporative capacity of 3.45 million lb./hr. of steam. The steam conditions at the turbine stop-valve will be 2,300 lb./sq. in., 1,050 deg. F., with reheat to 1,050 deg. F. The capacity of the plant at Eggborough will be 2,000-MW, the same as at the new Ferrybridge "C," and West Burton power stations. They will, therefore, be the three most powerful steam stations in Western Europe. Work on site is expected to begin early next year, and the first unit is programmed to be commissioned in 1966. The station is due to be completed in 1968, a year after the completion of Ferrybridge "C." These stations must be developed quickly in order to meet the rapid growth of electricity demands, and the construction timetable envisaged was only made possible by the co-operation of the County Council, local authorities and other bodies concerned in the early planning stages. The boilers at Eggborough will burn more than five million tons of coal a year when fully operational and, with a similar consumption at Ferrybridge "C," a firm market for Yorkshire coal will be provided for many years to come.

INTERNATIONAL INSTRUMENTS, ELECTRONICS AND AUTOMATION EXHIBITION

The fourth International Instruments, Electronics and Automation Exhibition at Olympia, London, from May 28th until June 2nd, 1962 will, it is claimed, once again be the world's greatest display from this ever-expanding industry. Covering an area of more than a quarter-of-a-million square feet, nearly 500 firms of International repute, many of them from overseas, will show instruments and electronic equipment, from huge computers, to instruments capable of weighing and measuring each one of the millions of particles contained in a "hair's breadth," a considerable achievement in modern science. A feature of the 1962 I.E.A. will be the greater number of large stands—on an average individual stand space has increased by 20 per cent. This will ensure a more extensive display of the world's most up-to-date and reliable scientific instruments and electronic equipment, in first-class conditions. Industrial Exhibitions Limited, the organisers of the 1962 Instruments, Electronics and Automation Exhibition, state that they have already received many enquiries from intending visitors from some 20 countries overseas, and early indications are that the record-breaking overseas attendance of 4,000 visitors in 1960 will be exceeded, as well as the home attendance of more than 70,000 visitors. The I.E.A. Exhibition 1962 will show visiting industrialists and scientists from home and overseas, not only the latest developments in instrumentation and electronic equipment, but also the prototypes vital to industrialists and scientists in the years ahead.

EDUCATION FOR MANAGEMENT

At the annual dinner of the Institution of Production Engineers held at the Dorchester Hotel in London recently, Mr. Harold Burke, the president, said that in spite of the strides made in the field of education for management since the end of the war, the United Kingdom was still well behind the major world powers in training sufficient personnel to organise and control industry. An intensified effort was needed in the universities and in the technical colleges to increase the facilities for the study of production engineering and management control, and both industry and the Government, Mr. Burke said, should share the responsibility of providing such additional facilities as were required to permit all universities and colleges to accept a greater number of students. Mr. Burke went on to suggest that the Government should appoint a leading industrialist as Minister of Production to advise the Cabinet on the country's industrial and economic affairs and, aided by a planning board of industrialists, to take effective action to advise, and if necessary, direct industry. If British Railways considered that it was important that it should have a top-ranking industrialist to direct its organisation, said Mr. Burke, how much more important it was that the whole country should have, at the head of industry, the most talented industrialist it was possible to find.

B.S.I. CHANGES

Changes have been announced within the technical directorate of the British Standards Institution. The number of technical sections has been increased from five to seven, the two new ones being concerned with (a) metallurgical and some engineering industries, and (b) safety and consumer standards; codes of practice work is now combined with building activities. There are concomitant staff changes. Mr. Gordon Weston, now technical director, has been appointed associate director; Dr. H. M. Glass, deputy technical director, becomes technical director; Mr. J. F. Stanley, divisional chief technical officer for electrical and related projects, is now deputy technical director (electrical); and Professor C. A. Geneve, divisional chief technical officer in charge of codes, personal safety, metallurgical and other standards work, is appointed technical adviser (special duties) and will be primarily concerned with developing standards projects for refrigeration, shipbuilding and structural work. Five former senior technical officers are now promoted to divisional chief technical officers with

responsibility for one of B.S.I.'s main channels of work. They are Messrs. R. Berry, P. Bingley, J. Brown, R. A. McKinstry and A. F. B. Nall.

COAL EXPORT DRIVE

In a drive to increase exports, the National Coal Board will have the largest single exhibit at the All-British Trade Fair, to be held in Stockholm from May 18th to June 3rd, 1962. A huge hollow pyramid of coal, together with coke and by-products outside the main exhibition hall, is planned as the central feature of a 9,000 sq. ft. exhibit. Inside the pyramid, according to N.C.B. plans, Swedish visitors will see miners working at a coal face with the latest British equipment. A giant symbolic figure of the British miner will stand outside the pyramid. This is the first time the N.C.B. has exhibited at an overseas trade fair. Professor Misha Black, Professor of Industrial Design (Engineering) at the Royal College of Art, has been invited to design the exhibit. The private enterprise sector of the British coal and coke industry, including the British Coal Exporters' Federation and the British Coking Industry Association, will co-operate with the N.C.B. in making the export drive a success. Last year, exports to Sweden of coal, coke and briquettes increased by almost £1 million compared with 1959. In 1959, Britain exported to Sweden 442,929 tons of coal, coke and briquettes valued at £2,382,665. In 1960, she exported 618,614 tons valued at £3,118,044.

PUBLICITY OVERSEAS

Stressing the need for more co-operation in selling electrical plant and equipment overseas, Mr. H. G. Nelson, managing director, The English Electric Co. Ltd., told the delegates at the recently-held BEAMA publicity conference, that the greatest efforts of British firms in export markets were often absorbed in competing among themselves and not in meeting foreign competition. Mr. Nelson, who was guest of honour at the final luncheon held in connection with the conference, provided something of a background to the earlier discussions by giving delegates a very able and broad summary of the problems confronting the electrical power plant manufacturing industry. He emphasised the need for fully realising and learning to live with, the factors that were producing the changing pattern of trade both at home and overseas. It is probably true to say that the first priority was to reduce costs, and this meant approaching and dealing with other problems from a somewhat different angle. It did not mean reducing quality or wages, but manufacturers should ensure that they got the best for what they did pay. They must also study the structure of the industry and ask themselves whether they could afford to have so many individual companies engaged in it. Mr. Nelson said there was room for improving the industry's reputation for delivery and service, and for more forceful and imaginative selling. They should also take good care, as Continental firms were doing, to ensure the background of a healthy home industry. Two things of considerable importance that they should avoid doing were to reduce their research and development effort and traditional standards of quality. They must, however, study the efficiency with which research was carried out and stress value for money in all selling activities. Earlier the benefits of bringing the publicity section into the planning of sales and marketing at an early stage were stressed by Mr. G. M. C. Peacock, publicity manager, Babcock and Wilcox Ltd., and chairman of the BEAMA Publicity and Exhibitions Committee. Later, delegates were given an example of how this had been achieved in the case of AEI-Hotpoint in a talk by that company's marketing director, Mr. G. A. Ganderton. Mr. Peacock also referred to the "agonising reappraisal" necessary if the electrical industry was to assert itself in a huge and competitive European market when most of its previous export experience had been of trading within the Commonwealth, and at the same time, was to hold its own against the flood of European competition. That there is considerable scope for collective publicity activities by electrical firms in overseas markets, and some misunderstanding of what it involved, was made clear in the discussion session led by Mr. M. L. G. Balfour, export publicity and fairs officer, Board of Trade, and Mr. G. T. M. Bagnall, manager, publicity and information services, The English Electric Co. Ltd. Mr. Balfour emphasised that the Government could not sell for industry, but could help in preparing the client. Mr. Bagnall suggested that collective efforts could well be of particular value in influencing the laymen whose opinion counted for so much in placing contracts for capital plant. The days had long since passed when engineer negotiated with engineer alone. Financial, political and economic considerations were now brought to bear by "men impervious to purely technical arguments."

STANDING ADVISORY COMMITTEE ON GRANTS TO STUDENTS

The scope of the newly-constituted Standing Advisory Committee on Grants to Students is to be broadened as the result of consultations between the Ministry of Education, the Scottish Education Department and the Department of Scientific and Industrial Research. The committee, under the chairmanship of Sir Francis Hill, was set up last May following the report of the Anderson Committee on Grants to Students, to advise the Minister of Education and the Secretary of State for Scotland on questions arising from the system of awards to students from public funds. It has now been agreed with the Minister for Science that its terms of reference will in future be extended to include consideration of D.S.I.R. post-graduate awards in science. This means that the committee will now be able to advise all three Ministers about both undergraduate and post-graduate awards within the field of the three departments. Three members of the D.S.I.R. Post-graduate Training Awards Committee have been nominated to serve on the committee. These are Professor P. V. Danckwerts, G.C., M.B.E. (Shell Professor of Chemical Engineering, Cambridge University), Dr. D. M. A. Leggett (Principal, Battersea College of Technology) and Professor J. E. Smith, F.R.S. (Professor of Zoology, Queen Mary College, London). The committee has already begun its first task which is to review the standard rates of grants for students at universities, students following courses of degree or comparable standard at further education institutions and students at training colleges. The committee hopes to make recommendations to Ministers early in the New Year.

Deaerator Design Considerations

By M. G. LACEY, M.A., A.M.I.Mech.E., P. A. JACKSON and P. G. JENKINS

THE object of these notes is to give a general description of the principles of deaerator design, which can be readily understood by those who have only a passing acquaintance with deaerators, without touching on the more controversial design details. No attempt is made to present any mathematical analysis of the mass diffusion phenomenon of oxygen from water to steam, which is the basis of deaeration. The article concentrates on the "feed heater" type deaerator as used for boiler feedwater conditioning. This is the main application for deaerators in this country. The closely allied field of "cold water" vacuum deaerators, where no heating takes place at all, is not dealt with, although the principles involved are broadly similar. The "cold water" deaerator is used for the prevention of corrosion in distribution mains. The deaerator designs described in this article are those of the authors' firm, William Boby & Co. Ltd. The basic principles of operation are, however, common to all manufacturers.

Function and history

The main function of a deaerator is to remove dissolved gases from water. The function of heating the water while deaerating may be a very important one, but is only a means to an end. In practice, the dissolved gases concerned are primarily oxygen, and second carbon-dioxide. The importance of removing these dissolved gases lies in the fact that they are causes of corrosion at boiler operating temperatures and pressures, not only in themselves but also when associated with other impurities. Deaeration can be carried out chemically, that is, by the addition of chemicals, such as sodium sulphite for absorbing oxygen, or caustic soda for absorbing carbon dioxide, but this article is only concerned with mechanical deaeration.

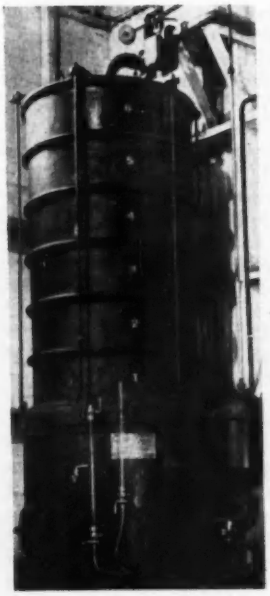


Fig. 1. Boby deaerator supplied in 1398 and still working satisfactorily over 50 years later.

The deaerator shown in Fig. 1 is one of the earliest known to the authors to be in existence in this country. It was supplied by William Boby & Company to Reavell & Co. Ltd., Ipswich, in 1898, and was still operating satisfactorily when the photograph was taken in 1951. It is a very crude and ineffective deaerator by modern standards, its action simply consisting in cascading the water while heating it by steam in a tank open to atmosphere. Raising the temperature of the water reduced the saturation point of oxygen, and the cascading effect allowed the steam to remove the surplus oxygen from the water and carry it out to atmosphere. The water was only heated to a temperature of approximately 200 deg. F., and the top of the tank was open to atmosphere. If the oxygen level was reduced to 1 p.p.m., the deaerator was probably considered to be operating satisfactorily.

With increasing boiler pressures and temperatures, deaeration of the boiler feedwater and condensate returns is becoming more common, and the performance of deaerators has been greatly improved. In this country it is generally considered that the boiler pressure has to be not less than 250 lb./sq. in. before a mechanical deaerator is worthwhile. In America and Canada, however, it is common practice to use mechanical deaerators for boilers at pressures of 150 lb./sq. in., particularly with the new packaged boilers which require low boiler drum concentrations, so that chemical deaeration is at a disadvantage. The American thinking, which has a good deal to commend it, is that some form of "hot well" or water storage must in any case be installed, and the extra cost of making this storage enclosed, and providing it with a deaerator dome, is relatively small. By doing this, not only is the water stored in a condition most appropriate for feeding to the boiler, but also the consumption of chemicals for after-dosing is very greatly reduced, and the blowdown from the boiler, due to the increase in dissolved solids from the use of chemical additives, is also reduced. Moreover, heating in the deaerator can often be carried out by exhaust steam, thus recovering heat which would otherwise be wasted. The extra capital cost of the deaerator dome and the enclosing of the storage tank is, therefore, soon recovered by savings in chemical consumption, boiler blowdown and waste steam, and no doubt this practice will gradually spread in this country.

A normal oxygen guarantee after deaeration for low-pressure boilers is now 0.02 p.p.m. and for high-pressure boilers 0.007 p.p.m., equivalent to 0.014 and 0.005 c.c./litre.

It is sufficient comment on the design of deaerator shown in Fig. 2 to say that of the deaerators so far ordered from deaerator manufacturers for installation in conjunction with the Central Electricity Generating Board's very large new turbo-alternator sets in the 275-MW to 550-MW range, about half are of this design. For comparison with the early deaerator shown in Fig. 1, Fig. 2 shows an outline arrangement of the deaerator being supplied to C. A. Parsons & Co. Ltd., as part of the feed-heating equipment for the 550-MW turbo-generator being installed at the Thorpe Marsh Power Station of the

C.E.G.B. This deaerator will be handling 3,600,000 lb./hr. of water, and will guarantee an oxygen residual of less than 0.007 p.p.m. of oxygen in the deaerated water.

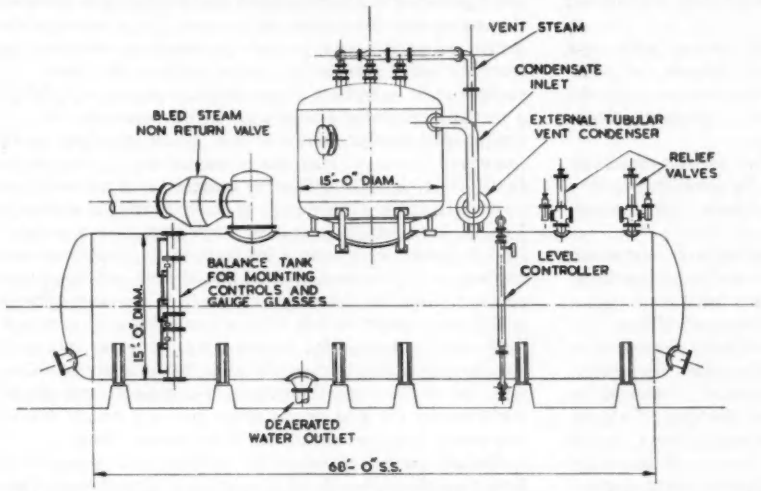


Fig. 2. Typical of modern designs of deaerator, are the two units for Thorpe Marsh generating station, C.E.G.B., each unit being designed to handle 3,600,000 lb./hr. of water.

This, and the corresponding deaerator in the No. 2 set at Thorpe Marsh, are believed to be the two largest deaerators under construction in the world today.

Basic principle

The basic principle of all deaeration is the application of Henry's law. This law states that the quantity of *gas* dissolved in a given quantity of solvent or solution is directly proportional to the partial pressure of *that gas* over the solution.

The words italicised are the key ones. Oxygen can only be kept in water by a pressure of oxygen in the surrounding atmosphere. If the surrounding atmosphere contains only, say, helium, the water will lose oxygen, whatever the pressure of the helium. Deaeration could, therefore, in theory be carried out with any inert gas such as helium. But steam is cheaper, and has the useful by-product of heating. In order to apply Henry's law in practice, and obtain the maximum degree of deaeration within the limited physical boundaries of a deaerator dome, a number of conditions have to be fulfilled which can be summarised as follows :—

(1) The steam atmosphere must be free from oxygen initially, and must be passing through the deaerator in sufficient quantity for the oxygen from the water to be removed from its vicinity so that the water is constantly being presented with a fresh oxygen-free atmosphere.

(2) Maximum contact area must be provided between the water and the surrounding atmosphere.

(3) Sufficient contact time must be allowed between the water and the surrounding atmosphere for equilibrium conditions to be attained.

(4) The surface tension of the particles into which the water is divided must be broken up sufficiently often to facilitate liberation of the gases.

(5) Sufficient carrier steam must be vented from the deaerator to transport the oxygen and other non-condensables which have been removed from the water.

(6) The water must be at boiling point.

The above may appear a formidable list of conditions. However, it is a good general guide in assessing deaerator performance to remember that the greater the contact area and the greater the contact time, the better the deaeration.

The following is a general outline of how the six requirements are met, with reference to the practice of the authors' firm.

(1) *Steam atmosphere*

Provided the steam itself is oxygen-free it is easy enough to keep the "atmosphere" oxygen-free during normal working conditions, assuming that the deaerator is working at a pressure above atmospheric. But oxygen-free steam is a prime essential.

If there are sudden fluctuations in the quantity or temperature of the incoming water to the deaerator, such that the steam supply and controls cannot keep pace, then there is a possibility of a transient vacuum condition which will pull air into the the deaerator. Even if the vacuum condition only lasts for a few seconds, it will be sufficient to aerate most of the water in the deaerator and in the water storage-tank associated with it, and it may take some hours to get rid of this contaminated water. Avoiding this danger is a matter of detailed engineering design as regards the steam supply and controls. An additional precaution is that the vent from the deaerator, instead of being taken to atmosphere, be taken to a turbine condenser or other vacuum vessel so that there will be no tendency to pull air back into the deaerator through the vent pipe.

The fitting of vacuum breaking valves is not generally good practice, since this simply makes it easier for air to get into the deaerator under transient vacuum conditions. It is usually preferable to make sure that the deaerator and associated storage-tanks are good for full vacuum conditions, and the vacuum breaker can then be omitted.

Much the most important difficulty in avoiding aeration of the contents of the deaerator and storage tanks is the danger arising from shut-down periods and associated starting up conditions. It will be readily appreciated that if a deaerator is operating at a pressure of 2½ lb./sq. in. g. (corresponding to an outlet temperature of 220 deg. F.) and is shut down over, say, a weekend, the temperature of the water in the deaerator feed tank is likely to drop below 212 deg. F., and the deaerator will, therefore, draw air in from the surrounding atmosphere through the vent pipe. The vent pipe can, of course, be fitted with a non-return valve but non-return valves can not be guaranteed not to leak, and they also require an appreciable pressure drop to open them in the normal direction of flow.

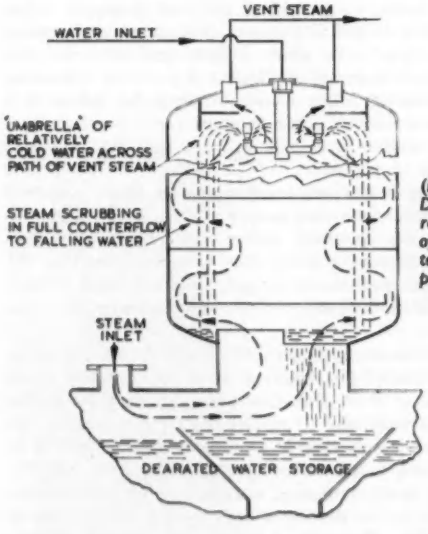
If a non-return valve is fitted in the vent pipe, it should be remembered that below a pressure of, say,

1½ lb./sq. in. g., no venting steam will be escaping so that no oxygen will be removed from the deaerator which will, therefore, stop deaerating (see Fig. 10). Better methods of guarding against this shut-down aeration danger are :—

(a) The provision of some off-load heating, such as a steam coil or electric immersion heaters, to compensate for radiation losses and so ensure that the temperature of the water in the deaerator storage tank is kept above 212 deg. F., or

(b) Maintaining a vacuum condition on the deaerator vent outlet so that however low the temperature may drop there will be no tendency to draw air in through the vent pipe.

As regards the question of maintaining sufficient steam velocity to remove the oxygen from the neighbourhood of the water, and so present the water with an oxygen-free atmosphere for further oxygen removal, this is best answered by providing full " counter-flow " between the steam on one hand and the water on the other. Evidently, when the water is almost fully deaerated, it should be scrubbed by the maximum possible quantity of steam, and this steam should be at its greatest purity, i.e. it should not have had any previous chance of removing oxygen from the water. At earlier stages a useful amount of deaeration can be done with less rigorous scrubbing by steam with a slightly smaller degree of purity, and so on all the way up the scale. This principle is fully realised in the design of deaerator dome shown in Fig. 3 where the " uncontaminated " steam meets the almost fully deaerated (and heated) water at the bottom of the dome. As the steam picks up oxygen from the water, the steam quantity is reduced by condensation, and it is brought into contact with water with a higher oxygen content and at a lower temperature.


VENT STEAM
WATER INLET
'UMBRELLA' OF RELATIVELY COLD WATER ACROSS PATH OF VENT STEAM
STEAM SCRUBBING IN FULL COUNTERFLOW TO FALLING WATER
STEAM INLET
DEARATED WATER STORAGE

(Left). Fig. 3. *Diagrammatic representation of a deaerator to show the principle of operation.*

(2) *Contact area*

Obviously if water is allowed to fall through a deaerator in large " lumps," then the oxygen in the middle of each " lump " of water will not have time to get to the outside surface of the " lump " and be transferred to the surrounding steam. Every deaerator design, therefore, incorporates some device for breaking up the water into small particles to promote maximum contact area between the water and the steam, and to give the oxygen in the centre of each water particle a minimum distance to travel before it reaches the water surface. An alternative technique is to bubble steam through water, but this is a method relatively rarely used in this country. In the design of deaerator shown in Fig. 3, the breaking up of the water into small particles is carried out in two stages, firstly by weight-loaded spray nozzles, and secondly by perforated trays. The design of spray nozzles is shown in Fig. 4, from which it will be seen that it is a weight-loaded spray nozzle, and is built up of two stainless-steel castings. This spray nozzle has a low and relatively constant head loss, varying from 10 ft. 6 in. water column at full load, down to 6 ft. 6 in. water column at very low load. It is not intended to break up the water into very fine particles, but it does do some preliminary atomisation and at the same time forms a complete umbrella of water across the area of the steam passage, which has an important function, described below under Point 5.

Having passed through the nozzles, the water then falls through a cascade of perforated stainless-steel trays which are so arranged that the steam has to follow a labyrinth path in counterflow to the descending water, being made to pass radially and horizontally through a vertical curtain of finely-divided pencils or droplets of water between each tray. This arrangement gives a very rigorous scrubbing action of the steam on the water droplets, and so provides extremely effective deaeration.

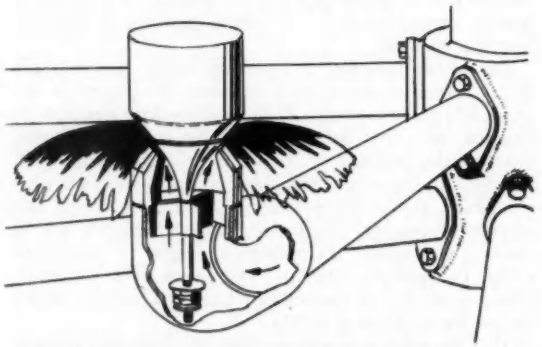


Fig. 4. Diagrammatic arrangement of stainless steel weight-loaded deaerator spray nozzle.

(3) *Contact time*

The contact time required for deaeration will vary with the effectiveness of the water/steam contact, i.e. the deaerator design. For a given design of deaerator, however, contact time must be increased in accordance with quantity of oxygen to be removed and/or temperature rise of the water required.

(4) *Surface tension*

This may be a rather unexpected point, but it should be remembered that a water droplet has a surface tension which increases inversely to the radius of curvature of the droplet, i.e. a small droplet has a relatively high surface tension. In order to pass from the water to the

steam, the oxygen has to overcome this surface tension, and if a droplet is allowed to fall freely through the steam, even for an indefinite length of time, there will tend to be a terminal value below which the oxygen residual will not fall due to this surface tension obstructing further diffusion of oxygen from the water to the steam. This apparently somewhat theoretical consideration is borne out by experience. On an early deaerator, experiments were carried out by varying the number of trays in a given deaerator dome, and it was found that when using six trays instead of four, a better degree of deaeration was obtained, even although the contact time with the six trays was actually less than that with four (due to the vertical space in the dome taken up by the additional two trays) because the water droplets were broken up six times instead of four, and the release of oxygen, therefore, facilitated. For the same reason, the authors would be very sceptical of any claims for really efficient deaeration obtained using deaerators with sprays only rather than a combination of sprays and trays, or some other device which has the same effect as the trays.

(5) *Carrier steam*

Obviously the oxygen which has been removed from the water must be taken out of the deaerator dome before it raises the oxygen content of the steam atmosphere and so slows down further diffusion of oxygen from the water to the steam. The best means of taking it out is by letting some steam escape from the deaerator dome, which will carry out the non-condensables with it. With a deaerator operating above atmospheric pressure, this can be done simply by opening up a venting pipe, but with a deaerator operating under vacuum, the carrier steam and the non-condensables have to be sucked out by means of an ejector or pump.

An important feature in deaerator design is the quantity of carrier steam which has to be vented from the deaerator dome to give efficient deaeration. If the quantity of carrier steam is large, then there is an important heat loss involved, and it is worthwhile passing this venting steam through some form of tubular heat-exchanger in counterflow to the incoming water so that the latent heat in the venting steam can be transferred to the water rather than being lost to drain. This tubular heat-exchanger is generally known as a vent condenser. It does not, in itself, possess any deaerating function, and its use is dictated entirely by thermal economy when the quantity of venting steam exceeds an appreciable figure. Since a tubular vent condenser of this type inevitably involves extra capital cost, extra running costs due to the additional head loss from pumping the water through the tubes, and also a certain amount of maintenance due to the corrosive nature of the carrier steam which will be saturated with oxygen, it is an item to be avoided if possible. One of the attractive features, and a patented feature, of the deaerator design shown in Fig. 3 is the fact that the arrangement of the weight-loaded spray nozzles forms a complete umbrella of relatively cold incoming water across the path of the steam. In this umbrella a large part of the heating and the deaeration of the water is done, as will be seen from the results of the Rogerstone tests described below. If some of the steam is permitted to break through this umbrella, it is found that this steam serves as the carrier steam, and carries with it the oxygen removed from the water. Moreover, it has been found in practice that the quantity of this carrier steam which is required for the efficient removal of the non-condensables is so small that an external vent condenser often becomes an uneconomical feature. In fact, the arrangement of the spray nozzles inside the vent hood of the deaerator forms an internal direct-contact type vent condenser, which replaces, and often renders unnecessary, any form of external tubular vent condenser.

(6) *Boiling point*

The definition of boiling point is that the water vapour pressure in the water should be equal to the pressure of the surrounding atmosphere. Under these conditions, the water is itself in a disturbed condition, and this helps to break down the surface tension and so promotes easier release of the oxygen within the water particle.

It should be noted (see test results on page 416) that a very considerable degree of deaeration can be achieved without the water being at boiling point. But boiling the water does accelerate the process and allows a lower oxygen figure to be achieved than could be reached without boiling.

"Vacuum" or "Pressure" deaerator

It is frequently asked whether it is best to deaerate under vacuum or at a positive pressure above atmospheric. Associated with this question is the secondary question of "what is the best temperature and pressure at which to deaerate?" In the authors' experience, there is no evidence to suggest that deaeration occurs any better or any worse whether the deaeration pressure is above or below that of the atmosphere. There is, after all, nothing magical about the pressure of 14.7 lb./sq. in. abs., such that pressures above this should encourage the removal of oxygen any more or less strongly than pressures below it. As a matter of practical convenience, however, there is no doubt that there is a great deal to be said in favour of pressure deaeration. With a vacuum deaerator, if a leak occurs at any connection on the deaerator shell, then air will leak into the deaerator, and the deaerated water will be contaminated. Moreover, it may well be extremely difficult to detect this leak, and it may even be necessary to take the deaerator off line in order to cure it. With a pressure deaerator, if there is a leak at a connection, this will be an outward leak, it will not impair the function of the deaerator, and there will be no difficulty in detecting it, and probably putting it right, without taking the deaerator off line.

Vacuum deaerators were more popular in the days when the design of economiser and/or boiler feed pump limited the temperature of the boiler feedwater to, say, 180 deg. F. In order to meet this condition, the deaerator had to work at a pressure of 7½ lb./sq. in abs., and was, therefore, a vacuum deaerator. As modern designs of economiser and boiler feed pump have to accept waters at high temperatures, pressure deaerators have become more general.

In stating above that there is no reason why a vacuum deaerator should not, in principle, work as well as a pressure deaerator, it should be clear that in both cases the authors have in mind a "heater" deaerator; that is, one in which the temperature of the water is raised inside the deaerator. Very often, however, people speak of a vacuum as against a pressure deaerator when what

they really mean is a " De-Heater " deaerator as opposed to a " Heater " deaerator. By a " De-Heater " deaerator is meant a deaerator in which the water is heated prior, and external, to the deaerator, and is then flashed down inside the deaerator shell. There is no doubt that this is not an efficient method of deaerating, and, whether the " De-Heater " deaerator is a pressure or a vacuum deaerator, it will not give as good a performance from the point of view of oxygen removal as a " Heater " deaerator. The reason for this is that with a " De-Heater," or " Flash," deaerator all the steam leaves the water immediately the water enters the tank, and this steam is flashed off upwards and out of the deaerator. As the water falls inside the deaerator shell, therefore, it is falling through a static steam atmosphere, and no scrubbing action between steam and water is taking place. This is shown diagrammatically in Fig. 5, and contrasts with the counter-flow principle incorporated in the " Heater " deaerator arrangement shown in Fig. 3.

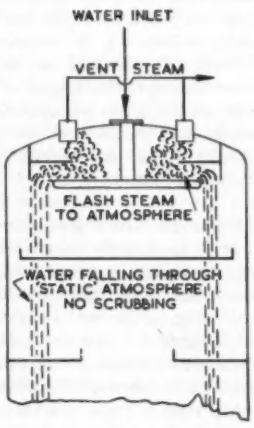


Fig. 5. " De-Heater " deaerator showing diagrammatically flow of water through a static steam atmosphere.

As regards the question " what is the best temperature at which to deaerate " there is no precise answer. For the practical reasons detailed above, it is better to deaerate at a pressure above, rather than below atmospheric, and preferably with an appreciable margin of not less than, say, 2½ lb. above atmospheric pressure to allow for transient pressure drops due to changing load conditions. If the pressure is taken too high, then this increases the cost of the deaerator tankwork, and if the deaerator is at any time subject to a temperature above 375 deg. F., it will probably be built to Class II tankwork requirements rather than Class III. If it is subject to a temperature above 650 deg. F., then it would probably have to be Class I tankwork, and this is normally avoided by introducing a Desuperheater to reduce the steam temperature. Broadly speaking, however, any temperature/pressure above 2½ lb./sq. in. g./220 deg. F. is suitable for deaeration, and in the U.S.A., pressures of the order of 100 lb./sq. in. g. are often used.

Corrosion

Since the purpose of a deaerator is to remove dissolved oxygen and carbon dioxide from the water, and so remove the corrosive properties of the water, it may well be asked why there should be any question of corrosion inside a deaerator. In fact the water will not have been fully deaerated until it has reached a point near the bottom of the deaerator dome, and the area in which corrosion can be expected to take place is at the top of the deaerator dome, near the point of entry of the water, and more particularly near the point of exit of the non-condensables and the carrier steam.

In a " Power Plant " deaerator (i.e. a deaerator which is treating condensate from a main turbine condenser on a closed circuit) the oxygen content of the water prior to deaeration is generally probably around 0.03 c.c./litre or less. Carbon-dioxide is also either absent, or present in extremely small quantities. Experience shows that with these power plant deaerators, even after several years in service, virtually no corrosion has taken place at all on the mild-steel surfaces inside the top of the dome. Before being put into service, these surfaces are, of course, protected by a coating of " Apexior " or similar paint, but otherwise no special precautions are necessary.

In the case of " Industrial " deaerators (i.e. deaerators which are treating either cold make-up water or a mixture of cold make-up water and condensate returns from a tank open to atmosphere) the oxygen content of the water prior to deaeration is likely to be very high, and there is also likely to be some dissolved CO_2 present. Under these conditions corrosion can indeed occur, and, according to the particular conditions obtaining on a given plant, it may be necessary to protect the inside of the deaerator dome by lining part of it with stainless-steel. The spray nozzles are in fact generally made in stainless-steel since, with a spray nozzle, it is not only a problem of corrosion but also of erosion. Deaerator trays are often also made in stainless-steel, even though this may appear at first sight something of a luxury. The tray perforations may, however, be very fine, necessitating the use of thin gauge metal, and any small degree of corrosion which could be tolerated on the main structure of the deaerator would cause a quite disproportionate loss of performance if it occurred on the trays.

Controls

The controls associated with a deaerator are the steam controls to maintain the desired operating pressure and temperature in the deaerator, and the water controls to maintain the required water level in the deaerator storage-tank.

In the case of power plant deaerators, the steam to the deaerator is normally taken from a turbine tapping, and the pressure at this turbine tapping will vary with the load on the generator. The operating pressure and outlet temperature of the deaerator, therefore, vary directly with turbine load. For reasons of thermal economy, the turbine tapping is taken as low down the pressure range of the turbine as possible, and a tapping which gives, say, 35 lb./sq. in. abs. at full load is likely to be less than 14.7 lb./sq. in. abs. at, say, 50 per cent. load. A higher turbine pressure tapping is, therefore, also brought into the picture with a separate pressure-sensitive control valve which will only open when the pressure in the deaerator falls to, say, 20 lb./sq. in. abs. When this pressure is reached, the high-pressure steam control valve, therefore, opens and maintains this pressure while the bleed from the main low pressure tapping stops. It is, however, essential that the main bled steam tapping should incorporate a non-return valve.

This bled steam non-return valve is, in fact, a very important feature of the deaerator design. Not only must it perform the obvious function of closing when the high-pressure steam control valve opens, and so preventing any bleed back of steam from this higher pressure tapping into the turbine, but it must also guard against the contingency of load shedding by the turbo-generator.

In an instance of load shedding, the pressure at the main turbine bleed point will fall to near zero, and unless the bled steam non-return valve closes immediately, the water in the deaerator and its storage-tank will flash off back up the bled steam non-return line, and into the turbine, and may well cause over-speeding of the turbine, since this steam will be uncontrolled. Further, in order that the bled steam can be used to greatest thermal advantage in the deaerator, the pressure drop through the non-return valve must be an absolute minimum, since every additional pound in pressure drop reduces the operating pressure, and hence the outlet temperature from the deaerator. This loss of temperature in the deaerator would have to be made up by additional heating in the H.P. heaters further down the feed train. This additional heating will be carried out by higher pressure steam from the turbine tapping, which is, in itself, less economical, and will also be done indirectly through tubular heat-exchangers instead of in a direct-contact heat-exchanger, such as is constituted by a deaerator.

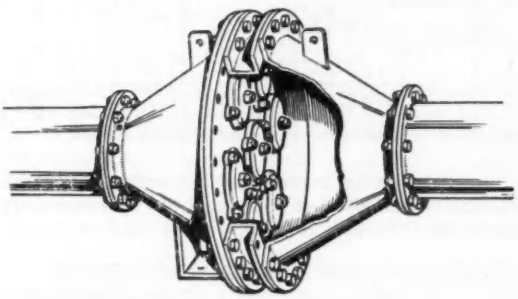
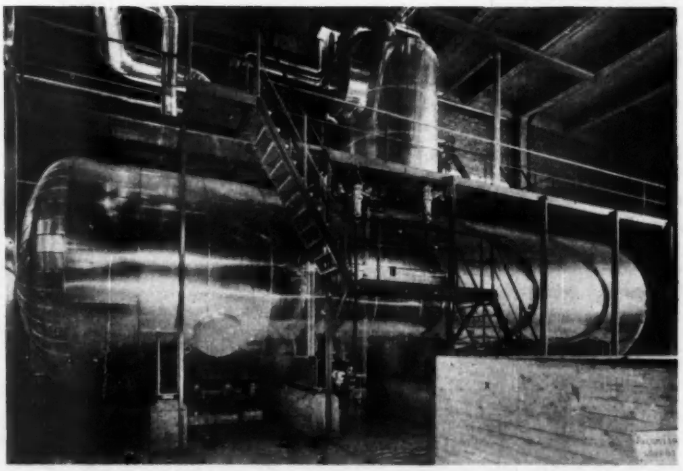


Fig. 6 (above). Sectioned view of specially-designed bled-steam non-return valve.

Fig. 7 (right). Baby deaerator installed recently at a Finnish paper mill at Heinola; the horizontal storage tank holds 175,000 lb. of water, a 30 min. supply.



There is, therefore, a serious loss in thermal efficiency. Lastly, and most important, the bled steam non-return valve must be really reliable, and there must be no danger of it jamming open due to any foreign matter in the steam. For this particular application, a special design of bled steam non-return valve has been developed (see Fig. 6) in which a number of component plate-type non-return valves (as made by Compressor Accessories Ltd., Birmingham) are mounted in a single steel diaphragm plate. These non-return valves have a very small lift, and the only moving part is a light stainless-steel plate. They, therefore, shut extremely quickly, and without shock, and by using a number of the valves in parallel a pressure drop of not more than 0.5 lb./sq. in. can be guaranteed. At the same time, the use of a number of valves ensures that the danger of any serious loss of steam from the deaerator, due to foreign matter jamming in one or more of the component valves, is minimised.

A test on one of these non-return valve installations on a 120-MW deaerator at the Drakelow "B" Power Station of the C.E.G.B. showed a pressure drop, measured by a manometer, of 7 in. water column, equivalent to 0.25 lb./sq. in. at full load.

The water inlet control valve on a deaerator normally takes its signal from the level of water in the deaerator storage-tank and is arranged to close or to by-pass the water to some other storage capacity when the level of water in the deaerator storage-tank exceeds a given figure. Conversely, when the level of water in the deaerator storage tank falls, the inlet control valve opens fully, and should the water level continue to fall, it is normal to provide some form of emergency low-level valve so that the boiler feed pump is supplied direct from the raw water storage-tank. The modern tendency is for these water control valves to be compressed-air diaphragm operated valves, and in order to avoid any form of gland sealing arrangement in the deaerator pressure-vessel which might lead to air leakage into the deaerator when the latter passed into the vacuum condition, it is usual to use the torque tube arrangement, such as incorporated in the Fisher Governor "Leveltrol" or other equivalent control units.

Oxygen measurement

A great deal has already been said and written on the subject of oxygen determination at the very low levels at which dissolved oxygen exists after deaeration in a modern deaerator. As already stated, the normal guarantee for oxygen residual for high-pressure boilers is 0.007 p.p.m., or seven parts of oxygen in 1,000 million parts of water, and when measuring to this order of accuracy, where the slightest contamination by the atmosphere would completely vitiate the results, a considerable technique is necessary. In the authors' experience there is no doubt at all that the method developed by Dr. E. C. Potter, as described in the Journal of Applied Chemistry Vol. 7 parts 6 and 8 and Vol. 10 part 1 is the best available chemical method for the determination of oxygen at this sort of level. At levels of 0.01/0.02 p.p.m. or higher, other less elaborate techniques can be used. However, it should be said in favour of Dr. Potter's technique

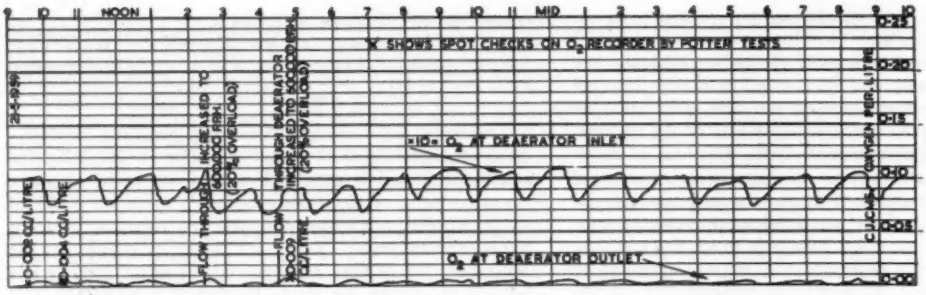

X SHOWS SPOT CHECKS ON O_2 RECORDER BY POTTER TESTS
×10= O_2 AT DEAERATOR INLET
O_2 AT DEAERATOR OUTLET
CUBIC C.C. OXYGEN PER LITRE

Fig. 8. Typical performance from industrial deaerator. Test with three trays.

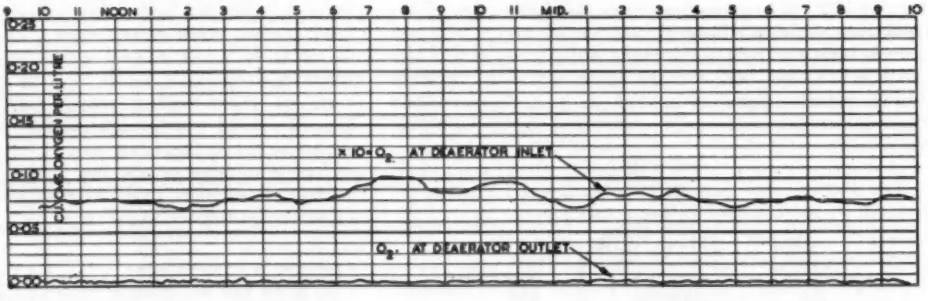


Fig. 9. Deaerator test with five trays, showing improved performance with increased number of trays.

that a competent chemist can be trained to use it in a week or two, and once this training has been completed, individual samples can usually be tested in a matter of approximately 20 minutes and accurate and consistent figures obtained. All the manual oxygen determinations mentioned in the tests described below were done by the Potter method.

Performance tests

The following field test results indicate the sort of performance which can be expected from a deaerator.

(a) *Industrial Deaerator* (at St. Anne's Board Mills, Bristol). Rated capacity 500,000 p.p.h. Oxygen guarantee 0.01 p.p.m.

Deaerator performance with three and five trays respectively is shown graphically in Figs. 8 and 9. The variations of oxygen content at inlet to deaerator are due to intermittent recirculation of condensate with lower oxygen content than the boiler feed make-up water.

It will be seen that the deaerator performance improves with the increased number of trays, particularly in that it becomes less sensitive to variations of oxygen content at inlet (see also Fig. 10).

Fig. 10 indicates the rapid effect of shutting off, and the even more rapid effect of re-opening the vent steam. It also shows that, with only three trays, the increase in oxygen at deaerator inlet from approximately 1 c.c./litre (Fig. 8) to approximately 1.5 c.c./litre (Fig. 10) gives a sharp increase in the figure of oxygen at deaerator outlet.

DEAERATOR PERFORMANCE AT ROGERSTONE

	Temp.	O_2
Inlet to deaerator	210	0.015
Tray 1	254	0.005
Tray 2	255	0.0035
Tray 3	257	*—
Tray 4	*—	0.002
Tray 5	261	0.002
Deaerator outlet	261	0.002

* Due to defects in equipment it was not possible to obtain accurate readings at these points.

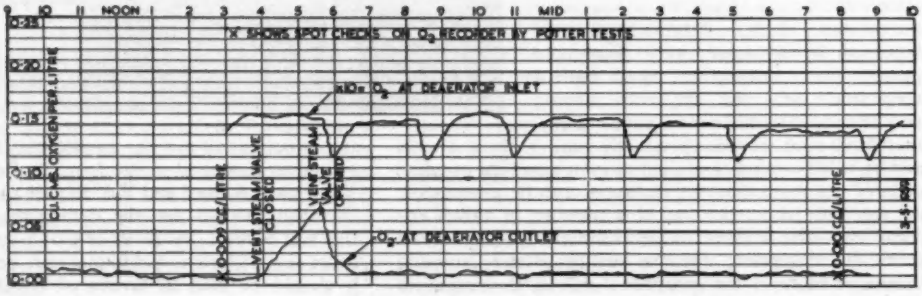

X SHOWS SPOT CHECKS ON O_2 RECORDER BY POTTER TESTS
×10= O_2 AT DEAERATOR INLET
VENT STEAM VALVE CLOSED
VENT STEAM VALVE OPENED
O_2 AT DEAERATOR OUTLET
CUBIC C.C. OXYGEN PER LITRE

Fig. 10. Effect of shutting-off and re-opening vent steam: test with three trays.

(b) "*Power Plant*" *Deaerator* (at Rogerstone Power Station of the C.E.G.B.). Deaerators working in conjunction with a 60-MW turbo-generator supplied by C. A. Parsons & Co. Ltd. Rated capacity 500,000 p.p.h. Oxygen guarantee 0.007 p.p.m.

The performance of the deaerator with varying inlet oxygen conditions and throughput load is shown in Fig. 11.

Permission was obtained to insert sampling tubes through the wall of the deaerator dome to measure oxygen residual and temperature at each of the five trays. The results are shown in the table on the opposite page.

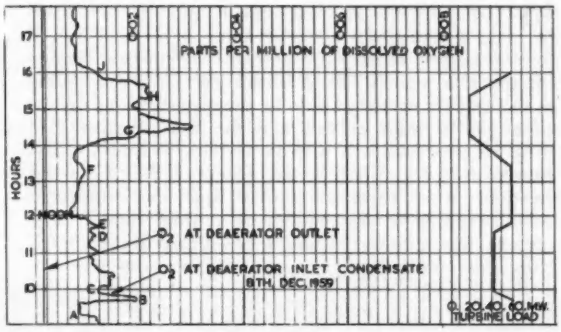


Fig. 11. Performance of a power plant deaerator installed at Rogerstone C.E.G.B. station, with varying inlet oxygen conditions and throughput load.

These results are of interest in showing that a large proportion of the temperature rise occurs before the first tray is reached, and that a large measure of deaeration is achieved before the water is brought up to the boiling point corresponding to the deaerator pressure.

Progress at Sizewell

WORK is ahead of schedule at the 580-MW C.E.G.B. nuclear power station which is being built by the English Electric, Babcock & Wilcox, Taylor Woodrow atomic power group at Sizewell, Suffolk. Foundations are half completed for the B. & W. 400-ton Goliath crane, which is being re-assembled at Sizewell, after its successful use at Hinkley Point nuclear station, as recorded in our last issue.

Progress on the two reactors is about six weeks ahead of programme and their outlines are taking shape. The 8-ft. thick foundation raft for both reactors and all the boiler houses has been completed, the concrete protective shield walls for No. 1 reactor are well advanced, while work has begun on the shield walls for No. 2 reactor. Most of the excavation has been completed in the pump house, through which 27 million gal./hr. of water will be pumped for the condensers, and the concrete is being placed for the foundation slab. As work is being carried out 30 ft. below sea level, "dewatering" has been achieved by deep well pumps, each pumping at least 30,000 gal./hr.

Two tunnels are being driven out to the cooling water intake which will be some 1,800 ft. off shore. In the north tunnel 240 ft. has already been driven, and work on the south tunnel is also well advanced.

In the turbine house, which will have two English Electric 325-MW turbo-alternators, all the bulk excavation has been completed, and work is going ahead on the inlet culverts for the circulating-water and on the foundations for the walls. Work on the turbo-alternator block foundations is to begin soon. Fabrication sheds for the two 63½-ft. dia. steel reactor pressure vessels and the eight boiler shells, which will be welded on site, are being erected.

The boilers at Sizewell, while not substantially larger (only 1 ft. in dia.), will have a heat-transfer capacity more than 50 per cent. greater than the boilers at Hinkley. This has been made possible by the increased pressure of the coolant and by an improvement in the heat-transfer properties of the tubes in terms of stud configuration.

Initial work comprised laying about 2½ miles of concrete-based roads, the construction of sewage works, a camp to hold 400 men which has already been completed and is now occupied by about 170 men, a canteen, site offices, plant shops, carpenter's shop and auxiliary buildings. The labour force, which will eventually rise to a peak of 2,000, now numbers about 1,000 men.

At their Dalmuir Works in Scotland, Babcock & Wilcox are well advanced in the shaping and preforming of the 4⅛-in. thick steel plating for the two

Construction of protective shield for Sizewell No. 1 reactor. In the background (right) is the Peine free-travelling tower crane.

63½-ft. dia. reactor pressure-vessels, and the first loads of plate sections will soon be transported to Sizewell for site-fabrication into the circular ring-courses forming the spherical vessels. Shop fabrication is also proceeding at these works on the 22 ft. 6 in. dia. ring-sections for the eight 91½-ft. high boilers, and the first shipments of these ring-sections will soon be arriving at South Quay, Lowestoft, for transport to site and final fabrication and erection. Work began on site last April and anticipated commissioning of the station is during 1965. The seventh nuclear power station to be ordered in the United Kingdom, Sizewell will have the highest output of any nuclear power station so far being built in the world. It will raise the total output of Britain's nuclear stations to 3,000-MW, which represents about 10 per cent. of the country's present total generating capacity.

Besides the enormous Goliath crane, use will also be made of a free-travelling Peine tower crane, stated to be the largest of its type in the world. This crane, which weighs 200 tons, is one of two made to Taylor Woodrow requirements in Germany. At present the Peine crane is operating at reduced height but, when fully erected, the height from ground level to mast top will be 220 ft., and with the lifting boom raised to its limit the maximum height will be 320 ft. The crane, which is unusual in that it " builds " itself by a hydraulic lifting device, is capable of lifting a maximum load of 10 tons or 5 tons at maximum radius of 164 ft., and is mounted on its own rails.

Cambridge Instrument Works Extension

AN instrument assembly wing providing some 15,000 sq. ft. of working area has been added to the premises of the Cambridge Instrument Co. Ltd. in Chesterton Road, Cambridge. As seen in one of the accompanying illustrations, the new wing has been designed to blend with the entrance hall and research laboratory block (opened two years ago), and consists of two raised storeys, with a ground-level car park beneath. Structurally, the two upper storeys consist of a box with a reinforced-concrete frame, approximately 150 ft. long and 50 ft. in depth, based on a solid concrete slab supported by two rows of circular columns from which the slab cantilevers outwards about 8 ft. front and back. The air supplied throughout the building is conditioned and filtered. Essential services (ventilation and heating inlets, gas, compressed-air, water, electrical services, telephones, etc.) are laid in horizontal floor ducts running the full length of the building below the windows, and (to reduce fire risks) all work-benches are wired with mineral-insulated, metal-sheathed conductors. Two penthouses on the roof contain air-conditioning plant. The building, which was designed by Edward D. Mills and Partners, architects, was completed in less than a year by J. Jarvis and Sons Ltd., general contractors.

The new assembly wing, which was formally opened on October 23rd last by Sir Keith Joseph, Bt., M.P., Minister of State, Board of Trade, represents the most recent example of the Cambridge Company's development programme, which, during the past two years, had included the opening of the new research laboratories, the doubling of the head office accommodation in London, extensions to the Muswell Hill (London) factory, and the purchase (in June, 1960) of the ordinary share capital of Electronic Instruments Ltd.—designers and manufacturers of high quality measuring units for scientific, industrial and nuclear instrument fields.

At a luncheon which followed the opening ceremony, Dr. P. Dunsheath, C.B.E., D.Sc. (Eng.), LL.D., chairman of the company, referred to the success of the Cambridge " Microscan " X-ray analyser for metallurgical research, which he described as an advance likely to have an impact comparable with that of the electron microscope. Nine of these instruments, he said, had now been sold to the U.S.A. and four to customers in Europe. The company's export business had increased from £360,000 to £525,000 (46 per cent.), between 1959 and 1960, and this year, the figure should exceed £600,000.

Research and development work on X-ray microanalysis and allied techniques is continuous, and, where necessary, the standard Cambridge " Microscan " X-ray analyser is modified or supplemented in order to increase its versatility. In conclusion, Dr. Dunsheath made reference to an agreement which had just been concluded between The Cambridge Instrument Co. Ltd. and Instrumenti di

New instrument assembly wing (left) of the research laboratories of Cambridge Instrument Co. Ltd.

Misura-C.G.S. of Monza (Milan, Italy), for the formation of a new joint company, Cambridge-C.G.S., which will have its factory at Casoria, near Naples. Cambridge-C.G.S. will initially manufacture instruments based on Cambridge designs, including electronic and galvanometric indicators and recorders for a wide range of applications, and associated control equipment. These will, where necessary, be adapted to meet the requirements of the Italian and neighbouring markets. Distribution will be in the hands of C.G.S. and Soc. Ing. Taragni, the latter having for many years acted as agent in Italy for the Cambridge Instrument Co. Ltd.

After the luncheon, guests were given the opportunity of inspecting the new wing, and various exhibits representative of production and development work at Cambridge. Demonstrations were given of the "Microscan" analyser, and work was seen in connection with adapting the instrument for slow scan rates, down to 1 micron per min. The unit developer for this purpose could be used either to generate an ultra-slow, single-line scan, or produce a slow raster in conjunction with the existing "Microscan" line timebase circuit. Improvements in the "Microscan" power supplied are also in hand; measurements are being made of an 80 kc./s. ripple which occurs in the oscillator-derived e.h.t. supply with a view to its elimination, and studies are taking place of noise in the neon voltage stabiliser system.

(Above). Second floor: the test room and galvanometer mounting department.

(Left). First floor: this view shows a part of the microanalyser department.

Also shown was a prototype data recorder for recording slowly-varying phenomena on tape and reproducing them, suitably accelerated, so as to appear as a complete wave-form on an oscilloscope. Improvements in Cambridge Katharometers, which are the primary measuring elements in the company's thermal conductivity gas analysers, are concerned with welding connecting wires to the filaments. Spot welds are being made under automatic time control by a condenser discharge circuit, and important reductions of resistance have resulted from the uniformity of the welds. Pilot production has begun of moving coil galvanometer movements having taut wire suspension in which the coil is suspended by metal bands providing control force, and electrical connections are replacing wearing parts such as pivots, jewels, hair springs and current spirals.

The Cambridge Instrument Company was founded in 1881 by Horace Darwin (later Sir Horace), son of Sir Charles Darwin, F.R.S., the celebrated biologist. It started business in Cambridge with seven people and a small workshop, its first activities being devoted to the design and manufacture of instruments for experimental research in universities and laboratories. From these modest beginnings, the company has grown steadily in size and structure, extending its activities to include instruments in industrial, scientific, medical and educational purposes. It has now almost 2,000 employees, three factories (one in Cambridge, two in London), a new research centre, head offices and an associated company (Electronic Instruments Ltd.) in Great Britain; associated manufacturing companies in the U.S.A. and Australia; and extensive agents in more than 40 countries throughout the world.

Shortly after its foundation, the company gave up the small workshop where it had started production, and moved to larger premises in St. Tibb's Row, Cambridge, where it remained for a decade. Later, a new site was purchased in Chesterton Road, Cambridge, and the first workshop to be built there still exists today, surrounded by the modern buildings and plant of the chief (Cambridge) factory.

At the end of the first world war, the headquarters of the company were moved to London and the factories of R. W. Paul at Muswell Hill were purchased, thus greatly extending production and research facilities at a time when trade was again expanding and early pioneer work in industrial instrumentation was beginning to show promise. In 1922, the firm of C. Hindle (Inc.), makers of electrocardiographs, was acquired in the United States, and the Cambridge Instrument Company (Inc.) of America was then formed, with factories at Ossining-on-Hudson and offices in New York.

The company's success has been primarily due to the

quality and loyalty over a long period, of the individuals of which it is composed. An important contributory factor has been the close relations it has fostered with universities and research establishments. Many distinguished scientists and engineers, such as H. L. Calendar, E. H. Griffith, G. A. Shakespear, C. R. T. Wilson, etc., have brought their problems to "Cambridge," and their names are now inseparably linked to instruments that were designed, made and first marketed by the company. This tradition has continued, and evidence of it today is to be found in many centres.

The first activities of the company were devoted principally to the design and manufacture of instruments for physiological research and apparatus and for experiments in universities and research laboratories. Later, these activities were extended to include electrical, engineering, temperature measuring, and analytical instruments for both science and industry. Today, the company manufactures a range of instruments which find application in almost all fields of human endeavour—research, industrial, scientific, educational and medical.

In the measurement of temperature, they provide a complete range—from the simple, inexpensive mercury-in-steel thermometer to the multi-point electrical resistance thermometer outfit, from the total radiation pyrometer to the thermocouple. Analytical instruments include pH meters, polarographs, dissolved oxygen analysers, and gas analysers based upon the properties of thermal conductivity, paramagnetism and catalytic action. A new, non-destructive method of investigating the microstructure of metals and minerals is embodied in the scanning electron-probe X-ray micro-analyser (the "Microscan"), to which we have already made reference.

The company's research and development programme is based, firstly, upon the need for fundamental research into new and more elegant methods of measurement; secondly, upon the need to exploit fully the application of existing methods in science, industry and medicine, and thirdly, upon the need to improve and develop existing designs.

200-TON OVERHEAD CRANE

An electric overhead travelling crane having a span of 159 ft., and a capacity of 200 tons has been installed in the main turbine house of the C.E.G.B. Blyth "B" Power Station. The makers, Cowans Sheldon & Co. Ltd., St. Nicholas Works, Carlisle, believe this is one of the largest overhead travelling cranes in the world. The crane is also fitted with an auxiliary hoist of 30 tons capacity. Each Warren lattice-type main girder is 162 ft. 2 in. overall with two site joints. The upper boom of each girder comprises an R.S.J. placed centrally between two plate and angle beams of the same depth, supporting a flat bottom rail upon the top flange plate. The upper boom is connected to the lower boom by braced, double R.S.C's. Girders are of a riveted construction, fitted bolts being used at the two site joints. Each pair of girders weighs 80 tons. Each main girder is rigidly carried at the ends by a carriage of riveted box-section. The main girders are joined at each end by a lattice girder connected by fitted bolts to both main girders and end carriages, which allows vertical flexure and provides complete lateral rigidity to maintain the overall squareness of the crane on the track. The long travel motion is powered by two 55 b.h.p. motors giving a maximum rate of travel of 100 ft. per min. with a 200 ton load. The main hoist motion, capable of lifting 200 tons at 4 ft. per min., or 50 tons at 15 ft. per min. by change gear, is powered by a 90 b.h.p. motor. The barrels are fully-machined, with opposite handed grooving accommodating the rope in a single layer, and arranged to give a central lift. The main block is carried on 12 falls of steel wire rope, the forged-steel Ramshorn hook being carried in a steel crosshead fitted with a ball thrust bearing. The auxiliary hoist motion can lift 30 tons at 20 ft. per min. and is powered by a 60 b.h.p. motor. Both main and auxiliary hoist motions are fitted with electro-mechanical thruster brakes of 20 in. and 16 in. dia. respectively, mounted in each case between motor and first reduction gear, and operate on the combined flexible motor couplings and brake drums. The main hoist has two of these units, the second being arranged to act in the event of a failure in the first unit. Because of the high output of the main hoist motor, semi-automatic airbreak reversing contactor control equipment is fitted, operated from a master controller. The crane, which itself weighs 258 tons, clears 70 ft. with the 200-ton, and 77 ft. with the 30-ton block.

Probably the world's largest overhead travelling crane is that installed at Blyth "B" Power Station of the C.E.G.B. by Cowans, Sheldon & Co. Ltd.

Proposed Thermal-Electric 120-MW Set for Dundee Extension

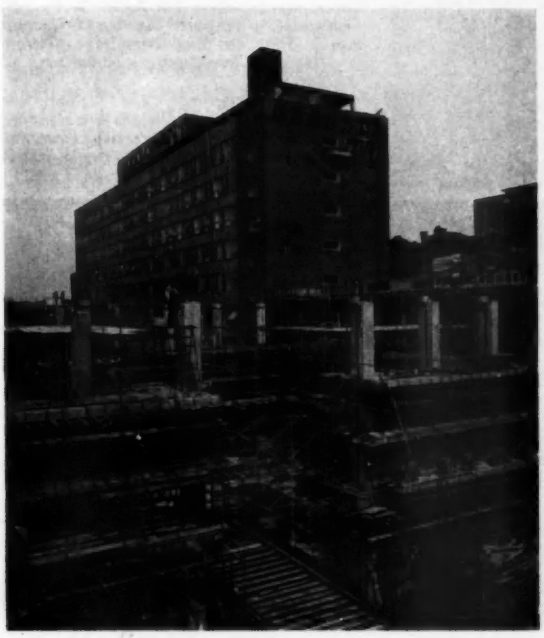
The North of Scotland Hydro-Electric Board has applied for the Secretary of State for Scotland's consent to extend the Carolina Port steam power station at Dundee, and to bring forward to 1965 the commissioning there of the 120-MW steam generating set included in the programme for 1966. A further addition is planned to follow within a few years. The new plant is planned for oil-firing. The Board states that "this increased capacity is needed to meet the growing demand of the Board's consumers, and will restore to a suitable level the proportion of thermal to hydro-electric generation. It will enable the Board to continue to make the best use of these two sources of power in serving its own area and meeting its commitments to the South of Scotland Electricity Board." The present generating capacity of the Dundee power station is 75,625 kW. The last extension was commissioned in 1957 when a 30-MW generating set replaced 18 MW of old plant. The consulting engineers for the project are Messrs. Strain and Robertson, 5, Park Circus, Glasgow, C.3.

Granada TV Centre—Manchester

WE were given an opportunity recently of visiting the Granada T.V. Centre, Manchester to see the progress made in the planned development of the five-acre site, which, six years ago was a derelict area in the midst of a slum district in the centre of Manchester. The most recently-completed part of the development (Phase IV) comprising a new office block ten storeys high, which, in addition to providing extensive office accommodation, makes available additional rehearsal rooms, a preview theatre, a residential penthouse and a main boiler house which will be developed to deal with the entire heating and refrigeration load of the site.

Work is now proceeding on Phase V of the development which includes the provision of two large studios, both of 8,085 sq. ft. to be known as studios 8 and 12. These studios will be linked to the existing studios and scenery storage areas by a 38-ft. wide scenery corridor above which are the control rooms for the new studios and a ventilation plant room dealing with this phase of the construction. The development also includes a five-storey block comprising additional dressing rooms, and makeup room at studio level, while at main floor level will be technical stores and engineering maintenance department. The remaining three floors will be rehearsal studios.

Reference might be made here to the previous phases of construction. It was during the autumn of 1955 that the main building contractors (J. Gerrard & Sons Ltd., Swinton, Lancs.) commenced work on the site—the sub-contractors for the reinforced-concrete being Truscon Ltd., London.



Work in progress on Phase V of the Granada T.V. Centre, Manchester, with Phase IV (the administration block) seen in the background.

The first television programme was due to be transmitted only nine months later. Time was desperately short—in fact many people considered it would be impossible to build the essential studios and complete the technical installation by the dead-line date for the opening broadcast. However, work progressed satisfactorily, and gradually the production, technical and planning teams came into existence and television rehearsals began, with the result that on May 3rd, 1956 television viewers saw the Granada symbol on their screen for the first time.

Work on Phase II commenced at the beginning of June 1957 and was completed within fifteen weeks. It included the building of what is known as studio 6, which at the time was claimed to be the largest television studio in Britain specifically built for the purpose, and one of the best equipped in the world.

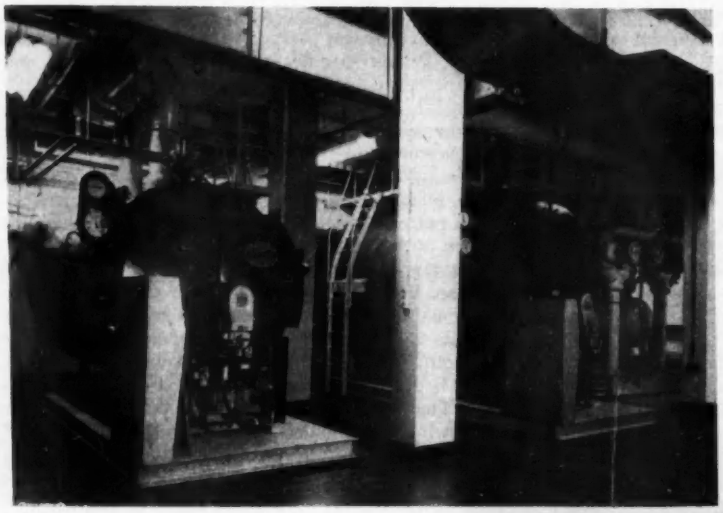
Phase III, on which work commenced on July 13th, 1958, comprised an extension (on three floors) providing new technical facilities and additional makeup, wardrobe and dressing-room accommodation. The new technical facilities included the extension of the central apparatus room to twice its original size, and the re-designing and extension of the central control room.

In the new ten-storey office block (Phase IV), we were able to see that the simple rectangular plan form of the building allows for offices to be placed on either side of a 7 ft. 10 in.-wide corridor. Column spacing is just over 17 ft. both transversely and longitudinally, and the building is of modular layout based on a module of 4 ft. $3\frac{5}{8}$ in. The foundations for the whole structure were taken down to sandstone with a safe bearing-pressure of 8 tons/sq. ft. and a reinforced-concrete retaining wall, varying in height from 8 ft. to 15 ft., contains the basement on three sides, the fourth side being the wall of the technical and dressing-room block. The majority of the floors are 7 in. thick and of beamless construction designed to carry the normal office loading of 50 lb./sq. ft. Upstand concrete beams are provided on their outer edges and these beams provide support for the curtain walling. A lattice-type mast, 90 ft. high is erected on the roof. Although the dead-load of the mast is not large, the possible wind loading effect is considerable and this has been taken into account on the structural design of the building.

Electrical installation

More than 50 miles of cable was used in the electrical installation for the Administration Block. This includes supplies for lighting, heating and ventilation, lifts, fire

alarms, impulse clocks and television programme distribution. The main supply from the North Western Electricity Board is metered at 6.6-kV and is controlled by Granada's high-voltage H.V. switch-room in the centre of the site. This switch-room controls local transformers, and 6.6-kV cable from the switch-room has been installed via the main underground service duct to feed a 500-kVA transformer in the basement of the administration block. This 6.6-kV cable will be extended to feed Phase V and return to the H.V. switch room as a ring main. From the administration block transformer 415/240 volt 3-phase 50 cycle a.c. supply is taken to a Brush cubicle-type switchboard installed in the H.T. switch-room. From the switchboard a 600 amp. 4-pole rising busbar system is installed to feed lighting and power on all office floors, each floor being provided with panels housing switch fuses and distribution fusegear. An electronically-controlled heating and ventilation system is installed, and all work in connection therewith was carried out with mineral-insulated and P.V.C. screened cable. An emergency lighting system is provided, and in the event of mains failure, safety lighting is maintained in corridors and staircases.



(Left). New boiler house showing Nos. 1 and 2 boilers which are of the Ruston & Hornsby Horizontal triple-pass, wet-back Thermax type. They are fired by Clyde "Hero" rotary cup forced-draught oil-burners.

(Below). Low-pressure and high-pressure circulating pumps and nitrogen pressurisation unit. The composite panel carrying Honeywell electronic controllers and Electroflo instruments can be seen at the right-hand side.

Heating and ventilation

The earlier phases of the development were heated from a low-pressure hot-water boiler-house located within Phase I development. The new main site boiler house in the basement of the administration block is being developed to deal with the entire heating load of the site, and the boilers in the original boiler house will be replaced by calorifiers. The main boiler house at present accommodates two Ruston & Hornsby horizontal type, triple-pass wet back Thermax boilers, one of 3 million B.Th.U./hr., and one of 6 million B.Th.U./hr. A further 6 million B.Th.U./hr., boiler is being installed to increase the capacity to deal with Phase V, and at a later date another boiler of similar capacity will be installed to complete the boiler installation.

An important feature of the Ruston horizontal Thermax boiler is the wet-back combustion chamber, which is fully-submerged and within the boiler shell. The outlet gases pass through the boiler flue (or flues) to the wet-back combustion chamber, thence through the first-pass of tubes to the smoke-box at the front, returning to the back of the boiler through the second-pass of tubes to the outlet chamber. A hinged door provides access to the internal combustion chamber, and manholes (according to the size of the boiler) arranged at the top and lower sides of the boiler shell, permit easy cleaning of the water space. The only brickwork required is the small amount needed to form the bridge at the rear-end of the furnace, thus considerably reducing the installation and maintenance costs. The overall dimensions of the boiler are considerably less than those of most other types of horizontal boilers, thus effecting a saving in valuable floor space.

The boiler plant is of the high-pressure hot-water type and is designed to operate at a flow temperature of 325 deg. F. and a return temperature, at full load, of 255 deg. F. The system is pressurised to 135 lb./sq. in. by a duplex nitrogen pressurisation unit made by Pressurisation Ltd. The boilers which operate in a full-flooded condition are fired by rotary cup forced-draught burners operating on 3,500 secs. oil, and supplied by Clyde Fuel Systems Ltd., Glasgow, who also supplied the duplex oil pumping and heating set. Two oil-storage tanks are arranged in a tank chamber adjacent to the boiler-house; one tank has a capacity of 20,500 gallons, and the smaller tank a capacity of 5,000 gallons. Both

tanks are equipped with combined H.P.H.W. and electric out-flow heaters.

The high-pressure hot-water pumping sets were supplied by Holden & Brooke Limited, Manchester, and comprise two 4 in. pumps having a duty (at present) of 215 gal./min. against a head of 24 ft. The pumps are complete with outboard bearing pedestals and are arranged with pulley-drive from 20 h.p. motors. The pumps are designed so that as the load connected to the boiler house is increased, the duties can be raised by changing the drives to a final duty of 500 gal./min. against 50 ft. head. The bearing on these pumps together with the bearing on the pumps in the pressurisation unit are connected to a closed-circuit water cooling system consisting of duplicate pumps and a forced air-cooling battery. Electrical drives are interlocked so that failure of the cooling-water system will trip out the main pump drive.

Connected to the high-pressure hot-water system are two horizontal non-storage water/water calorifiers manufactured by Holden & Brooke Ltd., each rated at 4 million B.Th.U./hr.; at a secondary flow and return temperature of 1,800 deg. F. and 160 deg. F. respectively. These calorifiers deal with the heating and ventilation plant in the administration block. Two Ryecroft (Bradford) vertical storage-type calorifiers are also connected to the high-pressure hot-water system and provide hot-water service to lavatories and kitchens within the administration block. The low-pressure hot-water heating system in the administration block is split into two zones (east and west) and each zone is served by a 2 in. Holden & Brooke pump having a duty of 107 gal./min against a head of 15 ft.

Heater batteries in the plenum ventilation system are served by a Holden & Brooke type 4 in. pump having a duty of 155 gal./min. against a head of 18 ft., and a further 4 in. pump is installed as a standby to the plenum and east and west heating zone pumps. An additional 1 in. pump is installed to deal with the panel heating in the main entrance hall. In the office areas, Ideal "Rayrad" radiators are installed, one per module of the curtain wall, so that irrespective of the arrangement of the one module office partitioning no alteration will be required to the heating installation.

Ventilation in the offices is provided by a plenum system which is arranged to give two air changes per hour in the areas having natural ventilation and five air changes per hour in the areas in the basement where no natural ventilation exists. The plenum heating system is split into four zones, upper and lower east and upper and lower west with individual controls. Extract fans are installed to deal with areas having no natural ventilation and a further extract fan is arranged to mechanically ventilate other areas. All the fans in the administration block were made and supplied by Matthews & Yates Ltd., Swinton, Lancs.

Controls

The oil-burners are of the modulating type with a 3 : 1 turn down ratio and to provide additional flexibility the boiler of 3 million B.Th.U./hr. has been installed. The controls on the heating calorifiers are of the Honeywell Electronic type and are arranged to maintain a constant flow temperature from the calorifiers of 180 deg. F. The east and west heating zones are separately controlled from external compensators via Honeywell Electronic Panels controlling mixing-valves. Because of the high solar gain as a result of the curtain wall construction, external solar type compensators are installed. The heater batteries serving the four ventilation zones are similarly controlled by external compensators and solar compensators. The combined panel which carries all electrical controls for the heating and ventilating plant together with the electronic control panels and associated release time switches, etc., was constructed by Rae Electric Ltd., London, and is installed in the boiler house.

Instruments

The boiler plant is fully-equipped with instruments which were supplied and installed by Electroflo Meters Co. Ltd. Multi-point remote thermometers give all high-pressure and low-pressure water temperature readings, and recording instruments are installed to record high-pressure hot-water flow and return temperature, boiler house temperature, percentage CO_2 at low level, flow temperatures and percentage smoke obscuration. Tank contents gauges and draught indicators are also installed. Provision has been made on the instrument panel for the installation at a later date of a B.Th.U. indicating and recording instrument.

The architect of the Granada T.V. Centre is Mr. Ralph Tubbs, O.B.E., F.R.I.B.A., who is well known as the designer of the Dome of Discovery at the Festival of Britain which was held in 1951.

THE LATE DR. B. L. GOODLET

It is with regret that we record the death recently of Dr. Brian Laidlaw Goodlet, O.B.E., M.A., Sc.D., vice-chairman of the Brush Electrical Engineering Co. Ltd. He was born in Russia in 1903, of British parents, and attended the Imperial School, St. Petersburg, before coming to England at the age of 16, after the Russian Revolution. He started work as a fitter-apprentice at Vickers Ltd., Sheffield, and continued his studies at evening classes in Sheffield University. He joined Metropolitan-Vickers Electrical Company in 1923 as a special trainee and technical assistant, and seven years later he was made head of the company's high-voltage research laboratory. There he designed and built a 1,000,000 volt impulse test equipment, and his work brought him into contact with Sir John Cockcroft and Lord Rutherford who sponsored his admission to Cambridge University as an affiliated student in 1930. After graduating in 1932 he returned to Metropolitan-Vickers. In 1936 he was appointed to the Chair of Electrical Engineering in the University of Capetown. On the outbreak of war in 1939, Dr. Goodlet joined the South African navy and, with the rank of Commander, became responsible for such technical matters as anti-submarine port defences, the degaussing of ships and bomb disposal. In 1943 he was seconded to the Admiralty as chief scientist of the Underwater Explosion Research Station at Rosyth. In 1944 he became scientific adviser to the Commander-in-Chief, Eastern Fleet, and a year later he was appointed engineering adviser to the Scientific Research and Experimental Department of the Admiralty, being awarded the O.B.E. for his services. After the war Dr. Goodlet returned to Capetown University as Dean of the Faculty of Engineering. In 1950 he came to England as deputy-chief-engineer of the Atomic Energy Research Establishment at Harwell, where his main responsibility was the development of nuclear reactors for electrical power generation purposes. He concentrated on the design of the gas-cooled graphite-moderated natural uranium reactor and worked with the team engaged on the "Pippa" project and on the Calder Hall reactors which resulted from it. In 1956, Dr. Goodlet left the A.E.R.E., Harwell, to become chief engineer and director of the Brush Electrical Engineering Co. Ltd. The following year he was appointed managing director, but in July last, ill health forced him to resign, and he was made vice-chairman.

Progress in Heat-Resisting Irons and Steels

By L. SANDERSON

THIS has been an important and interesting year in stainless and heat-resisting steel development. This article reviews some of the more noticeable advances. Attempts have been made in France to produce a martensitic high-chromium cast iron possessing more desirable properties than some of those previously existing. Research was carried out to determine with some exactitude the effects of modifying the nickel and chromium content on the mechanical properties and microstructures of the material. It was found that a eutectic, martensitic cast iron containing 5·5 per cent. nickel and 5·5 to 6·5 per cent. chromium produced an iron possessing great hardness but with much less brittleness than the previous nickel chromium alloy irons[1].

Another piece of Continental research, this time carried out behind the " iron curtain," was designed to develop a stainless steel with maximum resistance to corrosion, but with as low a nickel content as possible owing to the shortage of this metallic element. It was found, the statement is made, that two steels containing sheet made from two steels containing 18, 8, 2, 3 and 21, 18, 3, 4 per cent. of chromium, nickel, molybdenum and copper respectively, had resistances to corrosion combined with mechanical properties not excelled by the more expensive steel previously used containing 21 per cent. chromium, 38 per cent. nickel and 5·5 per cent. molybdenum[2].

An austenitic stainless utility steel for chromium nickel molybdenum castings also comes from central Europe. It is economical in nickel and is said to be virtually equivalent to 18-9 chromium nickel steels. It has good mechanical properties, can be reliably welded, and can also be polished. It is applicable mainly to high-pressure pumps, blading for water turbines, industrial fittings, etc. The composition of the steel is given as 0·11 carbon ; 8 to 9 manganese, 4·5 to 5·0 nickel, 19 to 20 chromium, 0·3 to 0·5 copper, and 0·20 nitrogen, per cent.[3].

American metallurgists claim that a new " superweldable " stainless steel is on the way, and that it will be resistant to weld cracks. The steel will contain 16 per cent. chromium, 20 per cent. nickel, together with alloying agents not yet disclosed[4].

The use of chromium plating of austenitic and high strength steels has been found by the German metallurgists to influence the sensitivity to stress corrosion. The tendency of the austenitic steels to this type of corrosion is a function of their composition. Chromium-plating provides a ferritic zone rich in chromium, which can act as an anode referred to the parent metal. Steels containing ferrite are in general less sensitive, as the ferrite is preferentially attacked, and the austenite cathodically-protected[5].

The commercial production of bright annealed stainless steel has been announced by a large company in the United States, which regards it as a major improvement in the surface lustre and corrosion resistance of stainless steels[6]. The low temperature impact resistance of austenitic stainless steels is adversely affected when these steels are subjected to carbide precipitation, while deformation at such temperature (—180 deg. C.) induces hot brittleness owing to carbide precipitation during deformation. French metallurgists have carried out researches designed to show whether contamination or addition elements known to produce temper embrittlement would cause low-temperature brittleness in austenitic steels ; and also, whether embrittlement during the deformation of austenitic steels in the temperature range conducive to the formation of embrittling precipitates would also occur in ferritic steels deformed under similar conditions. It was found that exposure to the appropriate temperature range can reduce the capacity of both types of stainless steel to deform at the test temperature, but the ferritic steels require lower rates of deformation. In addition to other discoveries, it was found that phosphorus, antimony and arsenic, known to promote temper embrittlement in ferritic steels, do the same to austenitic steels at low temperatures ; whereas boron proves beneficial in small amounts. The researches favoured theories of temper embrittlement in which carbon and its compounds play a major part[7].

A new fully-austenitic steel contains 0·07 max. carbon, 2·0 max. manganese, 1·5 max. silicon, 27·5 to 31·00 nickel, 19 to 22·00 chromium, 3·0 to 3·5 copper, 1·8 to 2·5 molybdenum, per cent. The new steel has, however, been found susceptible to hot-brittleness. The addition of vanadium by way of a proprietary alloy consisting of vanadium and other alloys of metallic type was found to minimise this sensitivity to hot brittleness, i.e. brittleness in the hot condition. As long as the carbon content of the steel lies within 0·0 to 0·07 per cent., the mechanical properties are approximately : tensile strength, 27 tons/sq. in.; yield strength, 12 tons/sq. in.; elongation, 45 per cent.[8].

Power plant materials

In steam power plants, severe cracking difficulties have been encountered with welds in a stainless austenitic steel containing 18 per cent. chromium, 12 per cent. nickel, 1 per cent. niobium. This cracking occurred in the zone of the weld affected by heat, starting at or close to the point where parent metal and weld meet. Ductility curves derived from tests show that there are two regions of low tensile ductility, in the regions of 850 and 1,100 deg. C. The first of these zones is attributed to niobium carbide precipitation induced by strain. The second zone is not regarded as bearing seriously upon the problem [9]. These niobium-containing austenitic stainless steels are now being extensively used both in this country and the United States. However, they have shown, when used for high-temperature applications in steam power plant, low rupture ductilities after long periods, during hot bending at certain temperatures, and when welded, in the zone affected by heat. Attempts have been made, therefore, to investigate the cause of this low rupture ductility. Various possibilities have been suggested as a result, and it is stated that ductility can be improved, especially in relation to bending strength and tensile strength, by ageing at 900 deg. C. after solution

treatment. The precipitation of niobium carbide, usually associated with warm working, has some influence in improving creep strength[10].

" Flow turning " is a new technique which has been applied to making stronger and lighter parts of stainless steel. If a sheet of nickel stainless steel is placed on a mandrel, rolled down so that it acquires the form of the mandrel, and removed, flow turning has been achieved. This is the general principle, though actually the technique is more intricate than this might suggest. The method has established itself by successfully producing lighter and stronger seamless products. Cylindrical and conical parts can be produced to highly accurate diameters and of uniform thickness, and this is facilitated by the excellent ductility of nickel stainless steel. Its work-hardening property also ensures a durable finished product, resistant to scratching and corrosion, and neither chipping nor peeling. The parts so produced are made in a single piece, eliminating joints that need solder or welds. There are no corners or beaded rims, so that they can be cleaned simply by washing, as there are no crevices or rough areas in which dirt or bacteria can collect[11].

New nickel alloy steel

A new revolutionary 18 per cent. nickel alloy steel with unequalled toughness at the highest strength levels of alloy steels has been discovered. It is the only known material, its inventors claim, that will give a yield strength above 112 tons/sq. in. while maintaining a nil ductility temperature below —62 deg. C. Another outstanding property is the excellent notched tensile strength, exceeding, it is claimed, 176 tons/sq in. (notch radius 0·0005 in.). A remarkable resistance to delayed cracking when exposed to a severe corrosive atmosphere in a highly stressed condition is found. These various properties are developed by a remarkably easy form of heat treatment involving the age-hardening of martensite, and known as " mar-ageing." It consists merely of holding for about three hours at 480 deg. C. and cooling in air to room temperature. Quenching is not required and heavy sections have no distortion. The composition of the steel is nominally (per cent.) : nickel, 18 ; cobalt, 7 ; molybdenum, 5 ; titanium, less than 0·5 ; and carbon, maximum 0·05. Easy cold forming and shaping, excellent machining properties, and ready welding with sound welds, are also claimed. The new steel is being patented[12].

Research has been carried out into the effect of vacuum-melting on the high temperature mechanical properties of a stainless steel containing 20 chromium, 20 nickel, 5 molybdenum, per cent., when minor additions of alloys were made. The most satisfactory results were obtained with a steel containing carbon 0·52, manganese 1·0, silicon 1·0, nickel 15·39, molybdenum 3·8, chromium 17·79, boron 0·5, tungsten 2·24, niobium 0·2 per cent. Tensile strength was 20·8 tons/sq. in., yield strength 15·5 tons/sq. in., and elongation 7 per cent., at 815 deg. C.[13].

Stainless steel condenser tubes in power plant proved highly effective in resisting the corrosive attack of highly corrosive cooling water, but its high first cost appeared to eliminate it as an economical substitute for 88-10-2 copper alloy tubes. After a period further investigation was made, and an entire surface condenser unit was completely re-tubed with 9,234 welded tubes of stainless steel. This was because it was found capable of much better heat transfer than was expected, while the resistance to corrosion ensured a long service life. The surface resisted fouling and corrosion, and cleanliness was more easily maintained. The wear and erosion resistance allowed thinner-walled tubes to be used. Wherever cooling water may severely corrode copper tubes, as when river water is contaminated by coal-mine drainage, stainless steel tubes may provide the answer. In the instance mentioned they were found to have a life-expectancy of 30 years as against seven years for copper[14].

Nickel base alloy

A recently-developed nickel-base alloy retains, in the cast form, more than 70 per cent. of its room temperature strength at temperatures up to 900 deg. C. Its high resistance to creep at temperatures up to at least 1,000 deg. C. is another economic advantage. The material has the following nominal composition : cobalt 20, chromium 10, molybdenum 5, aluminium 4·8, titanium 3·7, boron 0·01, carbon 0·22, silicon 0·25, manganese 0·25, iron, max. 2 (per cent.), the remaining percentage of the composition being nickel[15].

The grain-size properties of 18-8 chromium nickel steel containing titanium and used for superheater tubing have become of interest to the power boiler industry because of the premature swelling in service of fine-grained tubing. Some users have embodied a grain-size requirement in their specifications for these steels to ensure that the tubes are properly heat-treated, but such a requirement is not practical because there are difficulties in evaluating microstructures of irregular mixed grain sizes and errors may occur in grain-size determinations. Research has been carried out to throw light on recrystallisation and grain growth properties and the factors of importance in this connection[16]. One of the most important developments in chromium nickel stainless steels is the development of the precipitation-hardening alloys to meet the need for a material with as high a level of strength as heat-treatable chromium alloys, and a level of corrosion resistance approximating to that of austenitic chromium nickel types. This type was also developed to respond to low temperature heat-treatments to overcome scaling and distortion problems. The properties of such steels are determined by their structures. One type is martensitic, as-solution annealed and as-aged. Steels of this type have yield strengths of approximately 80 tons/sq. in. A second type of precipitation hardening stainless steel is austenitic as-solution annealed and martensitic as-aged. In the austenitic condition it will have good formability, and after heat-treatment, the yield-strength will be in the region of 71 to 90 ton/sq. in. A combination of high yield-strength and low permeability is possible with a steel which is austenitic as-solution annealed and as-aged A fourth type exhibits a duplex austenitic-ferritic structure. This type is used particularly to increase corrosion resistance in cast forms[16].

The corrosion resistance of austenitic stainless steels is being greatly improved by additions of copper and molybdenum. Finally a number of steels of stainless type have been developed for improved resistance to oxidation at elevated temperatures. Among these is a

15 per cent. chromium, 35 per cent. nickel steel which is said to be free from sigma formation and capable of being used at temperatures up to 980 deg. C.[17].

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BEAMA GOLDEN JUBILEE DINNER

Guest of honour at the Golden Jubilee Dinner of the British Electrical and Allied Manufacturers' Association held in London on October 31st, the Prime Minister, the Rt. Hon. Harold Macmillan, referred to the reducing cost of power through the combination of scientific knowledge and engineering skill. Less than four years ago, power stations were costing about £60 per kW. Stations coming into service during the next two years would cost only £40 per kW. Mr. Macmillan was proposing the toast of the electrical and allied manufacturing industry at the dinner, which some 800 members and guests attended. President of the Association, Mr. A. M. Browne, was in the chair; and Viscount Chandos of Aldershot, chairman of Associated Electrical Industries Ltd., replied.

The Prime Minister and Mr. Stanley F. Steward, Director of BEAMA, at the Golden Jubilee Dinner

The Prime Minister made an appreciative reference to the enormous strides which the industry had made since BEAMA was founded 50 years ago, and acknowledged that it was a great earner of foreign exchange, with exports around £300 million a year. This was a new and fine record, he commented, and the amount was still rising. There had been a net decrease in our "invisible" overseas earnings and it was, therefore, vital to secure a balance on "visible" trade. In this, the electrical industry must play a big part. We had many advances to show, including our nuclear power programme, our electronic control systems and computers. The industry had a very fine tradition of research and had produced remarkable results. BEAMA had taken a leading part in the formation of the Electrical Research Association and the British Standards Institution and it had also been active in international co-operation. After a passing reference to the European Common Market which, he said, offered both advantages and disadvantages, opportunities and dangers, Mr. Macmillan mentioned the need for the developed countries to go to the assistance of those less advanced. He concluded by affirming that electricity had a yet greater part to play and he proposed the toast with great confidence in the future of the industry.

In his reply, Lord Chandos referred to the industry's problems in financing its rapid development and to the importance of the producer in the economy of the country. The electrical industry was a key industry in every sense of the word. If they looked forward to continued expansion and to higher standards of life in this century, the electrical and the chemical industries must be amongst the leaders. The electrical industry was also one of the greatest sponges of capital. Man's ingenuity had outrun his ability to finance his inventions. In the electrical industry they had to spend vast sums upon research and development, upon plant and equipment, while the conditions of trade were becoming increasingly tight and profit margins were under very severe pressure.

The prospects of Great Britain joining the Common Market would appear likely to intensify competition. They were all, Lord Chandos said, trying flat-out to improve their efficiency and to increase their profits, so that they could sustain the large bill for research and development which they must carry if they were to remain in the forefront of progress in this ever-advancing, dynamic and changing industry. He believed that both in Government and in public opinion, the point of view of the producer was getting further and further into the background, whereas that of the so-called consumer was getting more and more into the foreground. Industry's contribution to revenue should be given more than a passing thought. They must be careful not to protect the consumer to such an extent that the industry from which he derived his income was made bankrupt by the mere extent of the protection which he was supposed to enjoy.

Although on broad principles, Lord Chandos declared himself in favour of the Restrictive Trade Practices Act, he made a plea that the producer should be rather regarded as the principal source of our wealth, someone, even to be wooed and cosseted and not only exhorted and warned. Referring to the Prime Minister's remarks on planning, Lord Chandos said that the electrical industry planned extremely carefully for many years ahead, and got a great deal of assistance from BEAMA and its officers. Since it took a year to plan a new plant, including buying the site, nearly two years to build it, and another year to bring it to full production, they had to plan on a minimum of about a four-year programme. Frequently planning went wrong but some of their mistakes were the fault of the Government. Of the total capital investment in the country, 40 per cent. was for the Government, Government agencies, nationalised bodies, and so on, and about this investment all too little was known. Business hoped that the new planning body would bring together and publish infor-

mation about the investment plans of these bodies. He estimated that not far off 40 per cent. of plant made by the electrical manufacturing industry went into Government use. Thus fluctuation in the Government's policy towards capital investment had a direct effect upon about 40 per cent. of the electrical industry. Moreover, the vagaries of purchase tax and hire purchase affected quite a large part of the remaining 60 per cent., and made it extremely difficult not to interpolate a good deal of guesswork into their plans. These problems had already occupied BEAMA's attention.

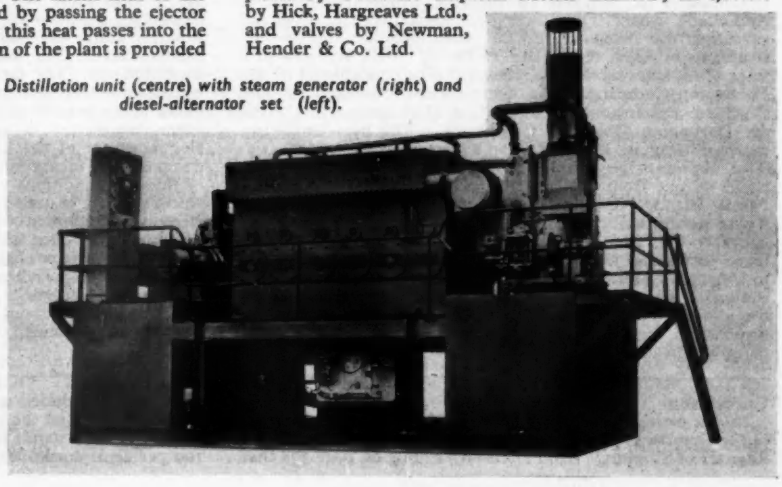
Referring to the strenuous efforts being made to keep BEAMA up to date, Lord Chandos stated that rulers will not find it short-sighted or narrow-minded, or immersed in the belief that it can go on entirely on its own in the matter of prices and markets, or that all our mistakes are other people's fault. He concluded by saying that export margins were now becoming so tight that if prices at home were to be subjected to similar pressures, " we shall be forced either unpatriotically to cease export business, or, patriotically and amidst the plaudits of the consumers and the economists, go bankrupt."

Mr. A. M. Browne wound up the proceedings by thanking the Prime Minister and the other guests for taking part in the Association's jubilee celebrations. He also expressed gratitude to the members, Mr. Stanley F. Steward, the director, and his staff for their co-operation and to Lord Chandos for his response to the toast.

THERMOFLASH DISTILLATION PLANT

A 25,000 gal./day self-contained sea-water distillation plant was recently shipped from the works of Bennis Thermoflash Limited, to the order of the Government of Abu Dhabi on the Arabian Gulf. It consists essentially of a thermoflash distillation unit, a steam generator to provide the operating steam, and a diesel-driven alternator to provide the electric power for driving the pumps and other auxiliaries. This plant is the first completely self-contained packaged Thermoflash installation. Sea-water feed is drawn from the sea by the feed pump via a coarse strainer at the end of the suction pipe and a fine duplex strainer adjacent to the plant. The feed is circulated through the vapour condenser and feed-heater tubes of the 11-stage distillation unit, its final temperature being 186 deg. F. It then flows in series through a number of flash chambers maintained at progressively higher vacua, the final stage operating at a vacuum of 28 in. Separators are in the form of a blanket of knitted Monel wire mesh. The sea-water remaining behind in the final flash chamber is discharged from the plant by the brine pump. The condensate is collected in each vapour condenser and cascaded down to the final stage, whence the distillate pump delivers it either to the storage tank built into the plant, or direct to the consumer. To ensure complete sterility of the distillate produced, an Electro-Katadyn unit is incorporated into the plant, and this effects sterilisation by imparting a steam of silver ions into the distilled water passing through it. This method has an advantage over certain other methods in that the sterility of the water does not deteriorate during periods of storage. As the feedwater boils upon entering the first flash chamber, the dissolved gases liberated pass into the condenser with the vapour, where they tend to remain behind after condensation. To prevent blanketing of the tube nest, the gases are removed by steam jet ejector and discharged to atmosphere. Another ejector at the final flash chamber removes the small quantity of gases released after the first stage, and also compensates for any air leakage into the unit from the atmosphere. The latent heat of the steam from both ejectors is conserved by passing the ejector discharge into the feed-heater, so that this heat passes into the sea-water feed. Steam for the operation of the plant is provided by a Clayton steam generator, and a storage-tank for boiler feedwater is built into the feed-heater of the distillation unit. Water from the storage-tank is pumped by the boiler feed pump to an accumulator. A circulating pump draws water from the accumulator, and delivers it to the single-pass spirally-wound heating coil in counterflow to the combustion gases that are passing over the outside of the coil. Upon leaving the generating section, the fluid passes through the thermostat tube and is delivered via the helically-wound water-wall tube to the separator in the accumulator, where dry steam is separated and delivered through the steam outlet to the distillation unit. The unevaporated liquid falls to the lower section of the accumulator for recirculation.

The steam generator is fitted with an automatic blow-down device which maintains the dissolved solids in the circulating water at an acceptable figure, the quantity of blow-down being adjustable, and being automatically proportioned to the feed-water rate. Since the condensed operating steam returns to the feed storage tank, only a small amount of make-up water is required and very little feedwater treatment is necessary. The steam space of the feed-heater operates at atmospheric pressure, any dissolved gases from the boiler feedwater or from the ejector discharge being blown direct to atmosphere. This feature enables a novel method of cooling to be employed on the diesel engine. Water from the boiler feed storage-tank is pumped to the diesel engine jacket at 212 deg. F. Cooling is effected in the jackets by partial vaporisation of the water, i.e. vapour phase cooling, and the resulting mixture of water and vapour is returned to the feed-heater, where the heat generally wasted in a jacket cooler is conserved by being transferred into the sea water feed. On full output of the distillation unit, the diesel generator produces approximately 50 lb./hr. of steam, which represents about 2 per cent. of the total consumption of the distillation unit, thus effecting a noticeable saving in fuel oil. The diesel alternator set comprises a 35 b.h.p. three-cylinder Dorman engine driving a standard 25-kW alternator. The output from the alternator is fed direct to the automatic control panel for distribution to the various pumps and control devices. The control panel carries all the instrumentation for the distillation unit and diesel generator, and incorporates the necessary pressure and vacuum gauges for sea-water and vapour, together with a distillate flowmeter and a distillate salinity indicator. It also incorporates certain safety devices which shut down the whole plant in an emergency. For this installation, the steam generator was supplied by Vulcan Foundry Limited ; the alternator by Arthur Lyon & Co. Ltd.; pumps by Precision Electrical Products (Stockport) Limited ; motors by Mather & Platt Limited ; tubes and tube-plates by Yorkshire Imperial Metals Limited ; air-ejectors by Hick, Hargreaves Ltd., and valves by Newman, Hender & Co. Ltd.



Distillation unit (centre) with steam generator (right) and diesel-alternator set (left).

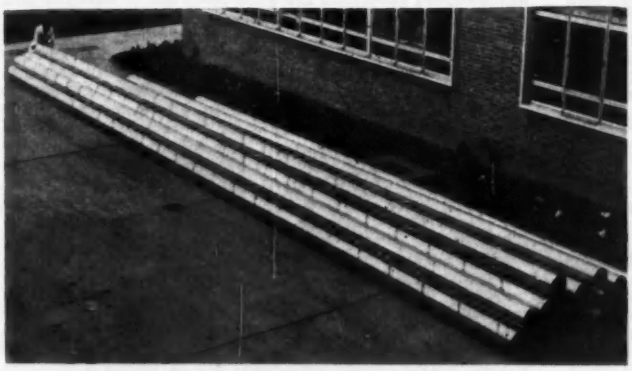
HELICAL-WELD ALUMINIUM PIPE

Large-scale production of aluminium pipe in sizes up to 28 in. dia. is now possible, due to the successful adaptation to aluminium of the helical-weld method of tube making. Until now, the two main types of aluminium tubing that were available in large quantities, extruded and drawn seamless tubing, have been limited by practical considerations to a maximum dia. of approximately 12 in. The method sometimes used to fabricate large diameter pipes, by bending plates into cylindrical shapes and welding them longitudinally, does not lend itself to large-scale production.

The method of making helical-weld tube consists essentially of feeding metal strip into formers or a series of rollers set at an angle so that the strip describes a helix as it travels through the machine. The resulting helical seam is then welded continuously and automatically. The tubing can be made in very long lengths and to accurate limits. The process was first developed for steel pipe at the end of the last century but it took many years of improvements in strip quality, in automatic welding techniques, and particularly in continuous weld testing and quality control, before the production of consistently high-quality helical-weld pipe became a practical proposition. Because of the increasing demand for thin-walled aluminium pipe in large diameters, Alcan Industries Ltd. (then Northern Aluminium Company) undertook in 1959 in collaboration with makers and operators of helical-weld equipment, a programme of development work on the production of helical-weld aluminium tube. The close tolerances to which aluminium strip is supplied permit welding to take place under excellent edge matching conditions. This is an important point which has contributed significantly to the success in making aluminium helical-weld pipe of consistently high quality. Moreover, welding is faster with aluminium than with steel, and the high speeds possible lead to high rate of output and low manufacturing costs.

Helical-weld tubing is now being offered, in sizes from 6-in. to 28-in diameter with wall thicknesses up to ¼ in., by three British companies: Apitubes Ltd., Bristol Aerojet Ltd., and The British Steel Piling Co. Ltd. Apitubes are producing pipe on helical-weld equipment designed and built at their Jarrow-on-Tyne works; Bristol Aerojet Ltd. have developed a different type of machine which produces helical-weld tube to exceptionally close tolerances for the more specialised types of application; and The British Steel Piling Co. Ltd. are operating a "Driam" helical-weld machine at their Claydon Works, near Ipswich. On the Continent at Oberhausen, near Dusseldorf, Intercontinental Enterprises G.m.b.H. are building their "Heliweld" plant. This equipment is capable of forming tube up to 120-in. diameter from strip up to ½-in. thick; it can therefore be used for making cylindrical vessels and tanks as well as tubing. For all trials on helical-weld machines in this country Alcan Industries Ltd. advised on machine adaptation and supplied Noral strip up to ½-in. thick in large coils of the higher strength alloys. Their associates, Aluminium Laboratories Ltd., Banbury, fitted the MIG and TIG welding equipment to the machines and established correct welding procedures.

There are many pipework applications where aluminium is claimed to have inherent advantages over other materials, but has hitherto been subject to serious size and cost limitations. The introduction of helical-weld aluminium pipe means that a new assessment of the role of aluminium in pipework is possible because it can now be obtained in a wider range of sizes and often at a lower cost than that made by other processes.



An example of helical-weld aluminium piping by Alcan Industries Ltd. The illustration shows large-diameter thin-wall pipes for an industrial plant.

Mr. A. E. Nixon, Managing Director (sales) of The Darlington Insulation Co. Ltd., recently returned from a three months' business trip abroad, including South Africa, India, Australia and New Zealand. Whilst in New Zealand, Mr. Nixon visited the Geothermal Plant of the New Zealand Government at Warakei (Consulting Engineers—Merz & McLellan), where The Darlington Insulation Co. Ltd. are executing the insulation of the main pipelines to the instructions of Aiton & Co. Ltd. of Derby. This is the second stage of the scheme, the initial stage also being insulated by the Darlington Company, using materials manufactured by The Chemical and Insulating Co. Ltd. of Darlington—another of the Darlington Group of Companies. The heat insulating material being used is Darlington 85 per cent. super magnesia. This important geothermal project is designed to utilise the water output from the hot springs at Warakei, which is in North Island, New Zealand, in connection with electrical power generation. The main piping contract, obtained by Aiton & Co. Ltd., includes the supply and installation of three 30 in. dia. transmission pipelines each two miles long, to convey the steam from the bore hole area to the generating station. In addition to supplying the insulating material for the piping installation, the Darlington Company are also responsible for the heat insulation work for the complete plant within the associated generating station.

DRAKELOW 'B' POWER STATION

In our article dealing with Drakelow "B" power station, published in the November issue of this journal, we included some notes on the electro-precipitator plant installed with the No. 5 boiler unit. We omitted, however, to point out that the electro-precipitators on the Foster Wheeler boilers (Nos. 6, 7 and 8 units) were installed by the Precipitator Division of Simon-Carves Ltd. (since transferred to Lodge-Cottrell at Birmingham). The flue gases from these boilers are cleaned by combined mechanical and electrical collectors. For each boiler unit a twin-flow, two-zone precipitator is installed. The outer casings are of reinforced-concrete, and the collector electrodes are of the high-efficiency, chute-type which have demonstrated their ability to deal effectively with a wide variety of flue-gas conditions. Spring-loaded, cam-operated, mechanical rapping is used to dislodge the precipitator dust. The electrical equipment comprises four high-tension, rectifier sets for each boiler unit, each set being of 60-kV, 250 mA capacity. They are of the static selenium-type, equipped with automatic voltage control and can be remotely controlled from the main boiler panel. Each of these Simon-Carves precipitators can handle about 408,000 cu. ft./min. of flue gas under M.C.R. The combined efficiency guaranteed at this load is 98.5 per cent.

Correction

In our article "Stress-relieving at Hunterston" published in the October issue, we referred to tests laid down by Lloyds Register of Shipping (Land Division), stating on page 338 that these tests "included crack detection tests on 10 per cent. of all nozzle welds on the inner heat shield and on the grid. . . ." We now understand that we were misinformed, and that 100 per cent. crack-detection tests were made on the diagrid.

RECENT Equipment AND Accessories

High-throughput metal-spraying pistol

Because the spraying speed of conventional wire and powder pistols cannot be increased by increasing the throughput of metals, without reducing the deposition efficiency very considerably, the model 61 metal-spraying pistol has been developed by the Coating Division of F. W. Berk and Co. Ltd. With an hourly throughput of 110 lb. of zinc, at a deposition efficiency previously only achieved with low throughput guns, an area of approximately 450 sq. ft. can be given an 0.004 in. thick zinc coating at a cost, it is claimed (including oxygen, propane, powder and labour), of about 4d. per sq. ft. The throughput is achieved by splitting the powder stream into four equal small streams and alternating these with gas streams. The gun weighs only 3 lb. (less than any other heavy-duty gun), and the gas, air and powder hoses all enter at the rear, thus giving good balance. Since this gun does not require to be as versatile in spraying all types of metals at all speeds with various gases as with the conventional gun, the only control on the model 61 gun is a spring-loaded trigger operating remote valve controls for gas and air supplies; in this way, main supplies are cut off when the trigger is released and the gun cannot be laid down under spraying conditions. Powder for the gun is fed from a 2-cwt. capacity container, a 1-cwt. drum of powder being tipped straight into it when required. The powder supply is cut off at the feeder when the trigger is released, preventing any build-up in the powder line to the gun or any wear on powder valves; the only parts subject to wear are the nozzles and the hoses feeding the material. As the powder feed unit is of fixed type, the operator is sure to work at the correct throughput in relation to the flame. A small box contains the controls, preset on final testing before despatch from the factory, and when first beginning to spray it is only necessary to open one cock and the compressed air supply is fed to the various air-operated valves ensuring that the correct volume, pressure and time sequence of air, gas, oxygen and powder is applied to the pistol. Less oxygen and propane is used than with equipment giving a quarter of the output of this gun and the number of guns employed in existing installations can be reduced. The coatings produced with this pistol are as fine and dense as those produced by a low-output gun and superior to other relatively high output equipment. (*Coating Division, F. W. Berk & Co. Ltd., Brent Crescent, North Circular Road, London, N.W.10.*)

New self-priming centrifugal pumping set

An extension to the range of Pep-loewe centrifugal pumps by the addition of the Pomona, a general-purpose self-priming unit, is announced by Precision Electrical Products (Stockport) Limited. The Pomona forms a compact portable pumping set and is available complete

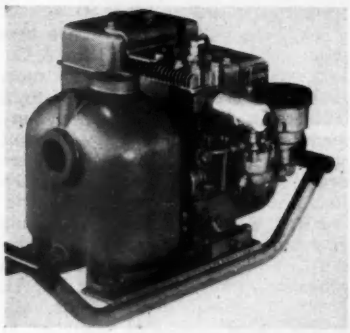


Fig. 1. Self-priming centrifugal pump-set [Precision Electrical Products (Stockport) Ltd.]

with either a four-stroke petrol engine or electric motor. The capacity of the pump ranges from 5,000 gal. per hr. against a head of 10 ft., to 660 gal. per hr. against a head of 89 ft. The self-priming capacity amounts to a 23 ft. suction lift and once the pump casing has been initially filled the unit is always ready for use. It is fitted with a semi-enclosed impeller which is unaffected by mud, dirt or sand and pumping can be carried out with solid particles in the water of up to ¾ in. dia. It is robustly constructed, and the rugged simplicity of the design makes it very suitable for all industrial, agricultural and contracting applications where rough handling is anticipated. The complete set is mounted on a lightweight tubular frame and the total weight of the complete set is 66 lb. [*Precision Electrical Products (Stockport) Limited, Lytham Street, Cale Green, Stockport, Lancs.*]

Withdrawable-type immersion heater

A withdrawable-type immersion heater by Eltron (London) Limited incorporates a magnesium oxide "Eltrofin" sheathed-element fitted into a pocket, in place of ceramic formers for carrying the resistance wire which are often a source of trouble. The heating element makes close contact with the pocket, thus giving a greater transfer efficiency. A higher loading for a given length is permissible with this type of heater and the element can be withdrawn from the pocket without having to drain the tank. As this type of element is practically unbreakable it minimises maintenance costs, it is stated. [*Eltron (London) Limited, Accrington Works, Strathmore Road, Croydon, Surrey.*]

Atmospheric-pollution recorder for process control

Isokinetic sampling apparatus designed for accurate and expeditious recording of dust, grit and fume emission from factory and other stacks has been developed by Visco Limited. Marketed under the name V.I.S.A., the equipment is a production version of an advanced system based on principles issuing from recent investigations by the British Iron and Steel Research Association into atmospheric pollution. Advantages claimed include the speed at which samples can be taken (the filter may be easily changed within 30 sec.), and the ease with which it can be used in confined spaces. It consists essentially of five linked units—sampling probe, filter unit, cooling coil, pump unit and instrument unit. In addition, there is a combined pitot tube and pyrometer for measuring gas velocities and temperature. The sampling probe, made of stainless steel, faces directly into the stream of dusty gas and a sample flows into the nozzle in the same direction and with the same velocity as the local undisturbed gas stream, so that the dust content of the sample accurately represents that of the main gas stream at that point. The

sample is then drawn through a filter of predetermined weight and cooled to ensure that corrosive liquids are not condensed in the sampling train. A gastight vane pump, equipped with a by-pass valve, then expels the filtered and cooled gas sample through a gas flow-rate indicator and an integrating meter. The filter is then re-weighed, and the concentration is obtained by dividing this mass by the volume of the gas sample. (*Visco Limited, Stafford Road, Croydon, Surrey.*)

Anti-corrosive lined valves and sight-flow glasses

Bascodur, an anti-corrosive protective lining for plug, globe, angle and low-pressure gate valves, and sight-flow glasses, is now available in this country through agents, I.V. Pressure Controllers Limited, who have the sole rights to this product. Bascodur-lined valves are manufactured in Germany. The material is composed

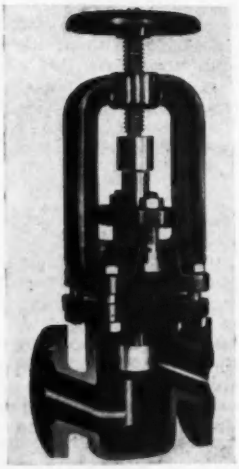


Fig. 2. Representative sectioned Bascodur-lined valve. (I.V. Pressure Controllers Ltd.)

of a carbonaceous base agglomerated by means of a thermo-setting resin. It is highly resistant to corrosion caused by chemical agents, acids, alkalis and solvents; it is capable of resisting elevated temperatures and performs well under rigorous hardness, shock and flexural tests. Due to this chemical and thermal resistance, Bascodur-lined valves are intended for use under the most severe service conditions. Bascodur is also usable in the presence of radiation up to a dosage of at least 10^8 rontgen, subject to modifications which may occur if very strong chemical factors are added to the action of the radiation. The plug, globe, and angle-valves are all suitable for pressures of 150 lb./sq. in. and temperatures up to 300 deg. F. (*I.V. Pressure Controllers Limited, 683, London Road, Isleworth, Middx.*)

Ultra-violet flame detectors

An extension to the range of Elcontrol FSM circuitry into the ultra-violet is afforded by u.v. detector heads types UV1 and UV2. They give better discriminating capabilities against other flames and incandescent refractory background in certain specialised cases. These units are basically new heads which can be used in place of the manufacturers' VH 31 infra-red-sensitive heads and work into standard FSM 5 (fully automatic) or FSM 1 (flame relay only) equipment. Both heads consist of a special u.v. photo-sensitive cell having a relatively high temperature stability, housed in a cast aluminium head, with an asbestos gasketed cover. The life of the photocell utilised is expected to be about two years. (*Elcontrol Ltd., Wilbury Way, Hitchin, Herts.*)

Small oil-fired boilers

With the introduction of two new types of burners, Henry Wilson & Co. Ltd. claim to have now the most comprehensive range of oil-fired boilers for central heating of any manufacturer in this country. Recent additions to the "Oilheat" range are two entirely different domestic units from those they have recently made. One is the "Wallflame" being made in two sizes of 60,000 and 90,000 B.T.U. The other is a fan-assisted vaporising boiler of 40,000 B.T.U. In the "Wallflame" boilers, the burner works on the principle of domestic fuel oil being drawn up a tube to a horizontal fan plate, revolving at 1,400 r.p.m. As the oil mixes with air, the mixture is thrown out by centrifugal force on to a stainless steel flame rim where it is electrically-ignited to burn with a blue flame around the walls of the inside of the boiler. There is no smell and the appliance is completely automatic. The thermostatic control knob is set on the front of the unit, the internal controls functioning automatically. When the necessary heat is reached in the central heating system, the oil flow stops and the burner goes out. When the temperature drops the burner relights by means of electric ignition plugs. The maximum fuel consumption is 0.46 and 0.75 gal./hr. respectively for the two units. The internal arrangement of the fan-assisted vaporising boiler has been planned so that all the controls can be reached by turning one screw to remove a plate. The vertical firetubes are easily cleaned from the top. All the controls are pre-wired and the fan and controls are mounted on one plate for easy access. The unit is fully-automatic, operating on the on-off principle by a permanently-lighted glow plug. This unit also incorporates the built-in Wilson, down-draught control on the flue. The maximum oil consumption is 2.6 pints/hr. (*Henry Wilson & Co. Ltd., Liverpool.*)

Non-storage pattern calorifier

The Royles type "D" calorifier has recently been redesigned to allow of increased efficiency coupled with a more compact unit, enabling a

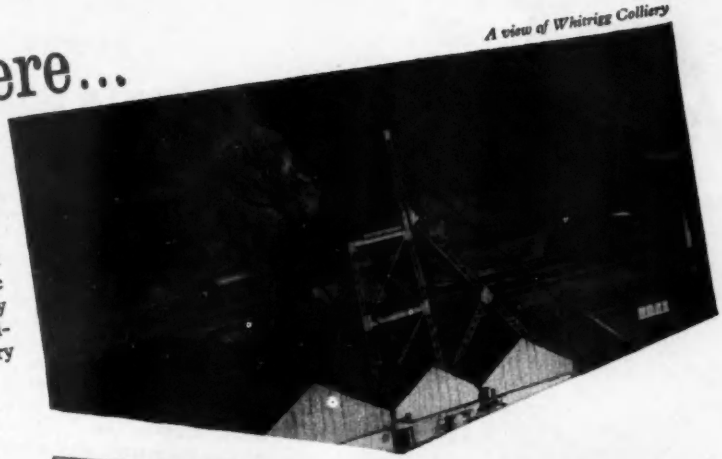
Fig. 3. Vertical form of redesigned non-storage calorifier. (Royles Ltd.)

reduction in cost of up to 40 per cent. Known as the type "D" Series 2, the construction is to B.S.S. 853 : 1960, and includes, as standard, combined eyebolts, collar studs and joint breakers on the steam cover. The patent indented copper tubing forms the heating surface as with the previous design. The tubes are arranged in battery form and can be withdrawn for cleaning or inspection and the individual tubes are also detachable. The calorifier is available in either vertical or horizontal form in 12 different sizes. The design now allows a maximum working pressure on the steam side of 150 lb./sq. in. and 100 lb./sq. in. on the water side. The ratings of the calorifier cover outputs of up to 16 million B.T.U./hr. The accompanying illustration (Fig. 3) shows the vertical pattern of the Series 2 calorifier. (*Royles Ltd., Irlam, Manchester.*)

Coal from here...

A tonnage equivalent to the entire output of a colliery will be consumed by the new British Motor Corporation factory now being erected at Bathgate in Scotland. The B.M.C. choose *coal* because coal has proved the most economical fuel for their purpose, because coal is home-produced and unaffected by policy changes abroad, and because our coal-fields can produce all the coal British industry will need for many generations to come.

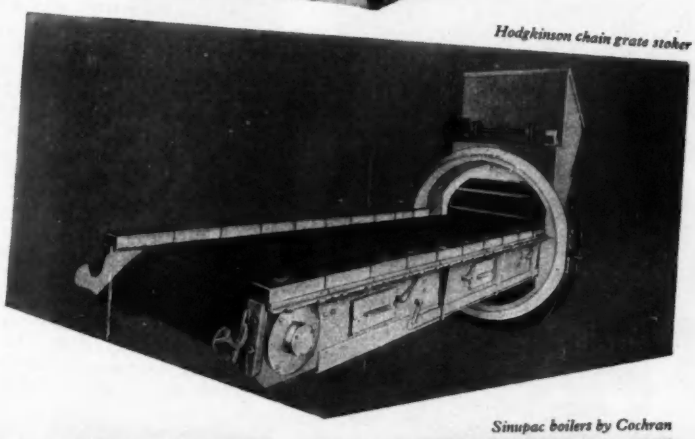
A view of Whitrigg Colliery



...will be fed...

Hodgkinson new design Mark V Chain Grate Stokers are being installed by B.M.C. for maximum thermal efficiency. These stokers maintain a flexible heat control, burn coal smokelessly and can cope rapidly with fluctuating loads.

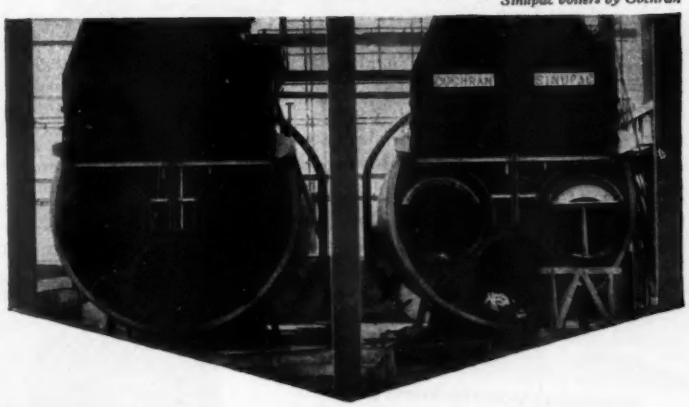
Hodgkinson chain grate stoker



...into these...

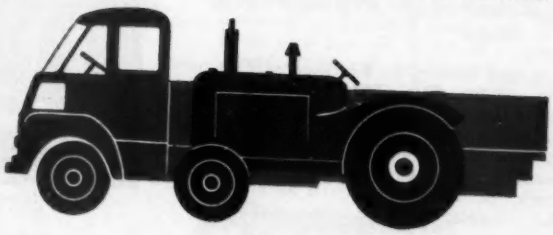
Five high-pressure automatically controlled, hot water Cochran 'Sinupac' boilers will each burn (per hour) 1.8 tons of untreated smalls containing 40 per cent fines. B.M.C. choose Cochran because, even with this low-grade coal, the efficiency will be approximately 80 per cent on the gross C.V. The total capacity of the five boilers is potentially 160,000,000 B.T.U.'s per hour. This will increase when the factory is in full production.

Sinupac boilers by Cochran



to power the factory that makes these...

The new B.M.C. factory—an important landmark in the industrial progress of Scotland—will produce approximately 400 tractors and 1,000 commercial vehicles a week, and will employ some 5,000 to 6,000 people. This new B.M.C. factory, burning British coal, automatically fired by Hodgkinson stokers in Cochran boilers, will increase Britain's prosperity at home—and British trade overseas.



BMC DRIVE AHEAD WITH COAL, HODGKINSON AND COCHRAN

Compact industrial level relay

Another version of the Leveltron industrial level controller has been developed by Thomas Industrial Automation Ltd. This controller is for use with two electrode units, one mounted at high-level and one mounted at a low-level position in a vessel, tank, or silo. Contacts on the relay of the unit switch the electrodes into the circuit as required so that, in effect, only one control unit is

Fig. 4. Dual electrode controller unit. (Thomas Industrial Automation Ltd.)

required for both high- and low-level control of pumps, conveyor motors, valves and so on. The control unit has one relay only which will become de-energised when the high-level position is reached by the material, and will re-energise when the material has fallen below the low-level electrode, thus providing an automatic interlock between the two levels. The main advantage of this system, it is stated, is the saving in capital outlay, since although two electrodes are required only one control unit is necessary. The instrument can be used with any of the standard range of T.I.A. electrodes, and the distance between controller and electrodes can be as much as 50 ft. The Leveltron, Type CS 101, can be housed in a sheet steel or cast iron case. (*Thomas Industrial Automation Ltd., Station Buildings, Altrincham, Cheshire.*)

Adjustable wall thickness gauge

An adjustable wall thickness gauge, additional to the standard range of Teddington air gauges, measures the wall thickness of plain bearings, cylindrical bushings and similar parts. The gauge will measure components from 1½ in.-7½ in. dia. and with up to ⅝ in. wall thickness. Besides thickness, the gauge will measure i.d./o.d. concentricity by variation in wall thickness as the part is rotated in the gauge. Open gauging nozzles are used, thus there are no contacts to mark the work piece. In addition, the tungsten carbide wear surfaces are super-finished to a surface finish of approximately one micro-inch. Adjustable support arms are fitted but these play no part in measurement, and merely serve to support the work piece in the gauging position. A pneumatic span-setting master is built into the gauge and the pneumatic calibration can be readily checked by turning a knob. All that is then required is a nominal size master to enable the adjustable upper nozzle to be positioned correctly for the particular size of work piece. The nominal master may be either a flat slip gauge or a work piece of accurately known size. To give speedy measurement the gauge is designed with the maximum clearance and this is 0.002 in.-0.003 in. beyond the thickest part that can be measured at any particular setting. The indicator gauge is liquid-filled and sealed giving a fast positive pointer movement. The gauge may have one of two measuring ranges : 0.001/0/0.001 in. reading to 0.0001 in. (magnification 1,800) or 0.002/0/0.002 in. reading to 0.0002 in. (magnification 900). An air supply at any pressure between 60 and 150 lb./sq. in. is required and the gauge is supplied complete with air filter with supply pressure gauge and 4 ft. of connecting hose. (*Teddington Industrial Equipment Ltd., Sunbury-on-Thames, Middx.*)

Small steam turbines

Vertical and horizontal turbines manufactured by Coppus Engineering Company of Worcester, Mass., U.S.A., are available in six casing sizes ranging from 1 to 250 h.p. to suit almost any steam conditions. A typical example is shown in Fig. 5. A wide range of output speeds is further extended by optional integral gears. A direct-acting adjustable governor and an independent overspeed trip can be included and all machines are

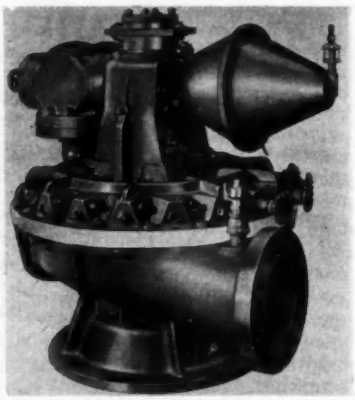


Fig. 5. Coppus steam turbine. (George Meller Ltd.)

of "brake-rim" construction. The design is claimed to be robust, allowing utmost operational flexibility ; the multiple nozzle control valves provide better steam economy on continuous part loads. The turbines comprise a two-row Curtis wheel on a sturdy shaft supported at both ends, the wheels being sealed by carbon rings. Lubrication is level feed and splash at the governor. Many types of pumps, compressors, fan generators and so on can be driven by a Coppus turbine, due to a wide range of standard materials, mountings, connectors and accessories to suit operation on steam, gas or compressed air. Further particulars may be obtained from the U.K. agents. (*George Meller Ltd., 24, Fitzjohn's Avenue, London, N.W.3.*)

Heating tape installation at power station

Among recent applications of Isotape heating tapes has been one in connection with fuel-oil plant serving

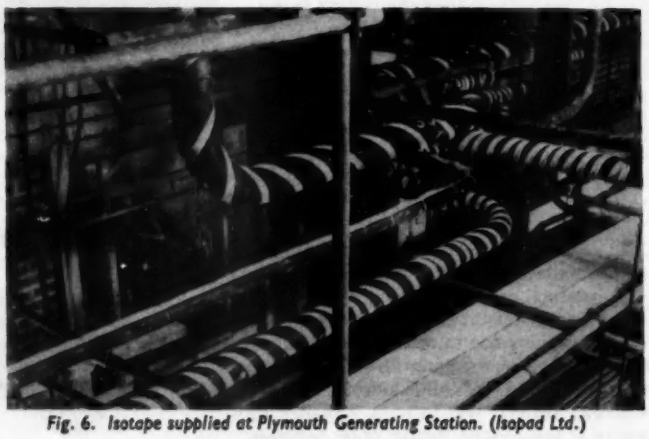
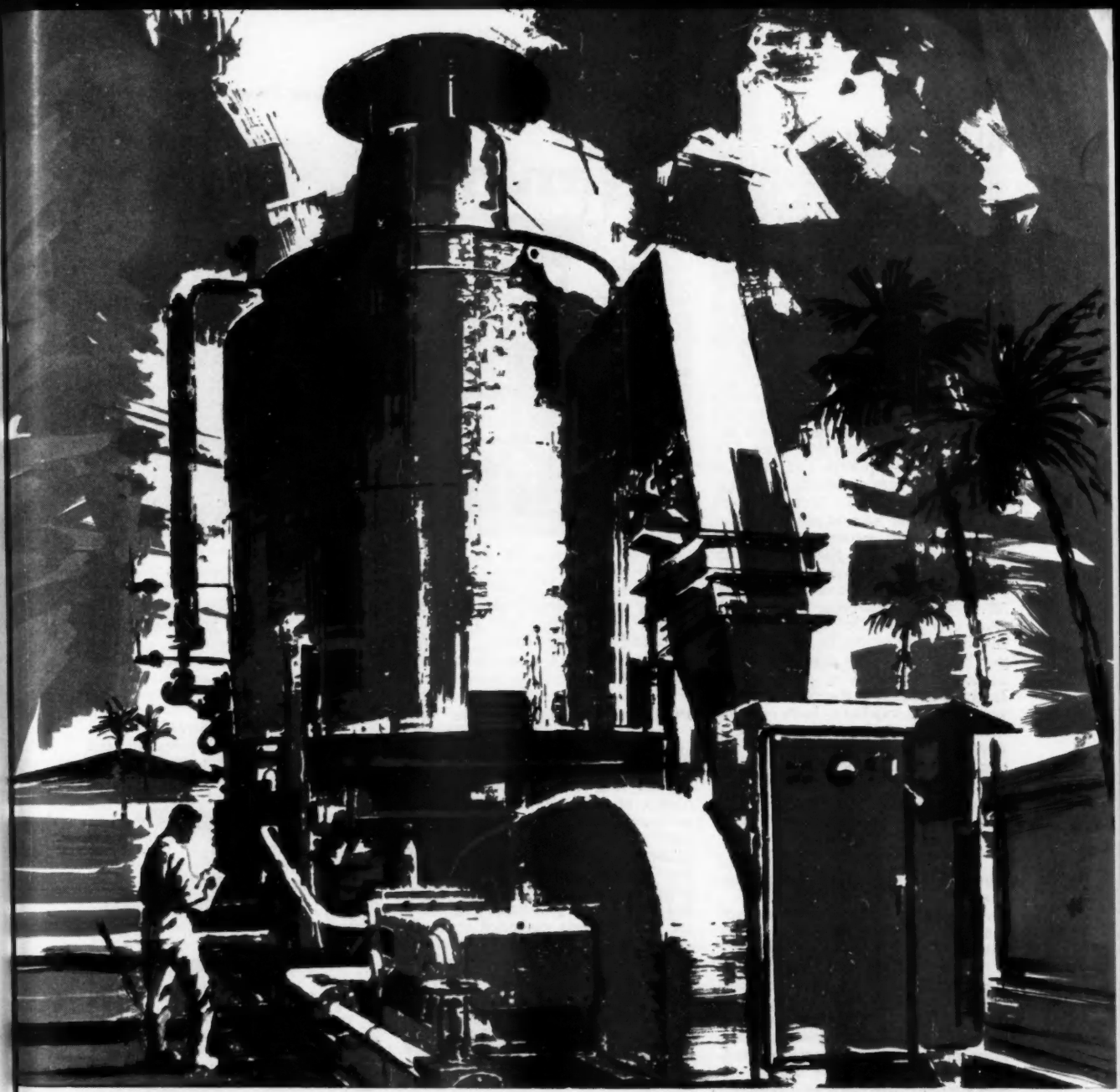


Fig. 6. Isotape supplied at Plymouth Generating Station. (Isopad Ltd.)



Mitchells 'packaged' coil boiler under test

Power in a Package

Mitchell's new 'packaged' boiler supplies 10 tons of high-pressure steam an hour for Shell oil wells in Venezuela

The requirements of Compania Shell de Venezuela for high pressure steam at their Venezuelan oil-fields dictated a boiler of a special type—a high pressure, forced circulation coil boiler with a capacity of 10 tons an hour. Mitchells designed and built a boiler to meet all these requirements and, in fact, it is now in full operation. Moreover, it is a true "packaged" boiler, i.e. one that can be shipped as a whole. Mitchells have thus paved the way for a whole new family of powerful, compact and transportable boilers.

Mitchells are also active in the fields of boiler design, cableways and ropeways, wagon handling, transporters and conveyors, cranes, mills, ship loading plant and nuclear power.

MITCHELL

MITCHELL ENGINEERING LIMITED
ONE BEDFORD SQUARE · LONDON

the Babcock boilers at the C.E.G.B. Plymouth Generating Station, which use fuel oil of 6,000-sec. Redwood No. 1 viscosity. This is kept at 60 deg. C. in three large storage tanks and the suction lines are maintained at 120-130 deg. F. by Isotapes. Some 8,000 ft. of heating tapes has been applied to the pipes varying from 1 in. to 6 in. bore, as seen in Fig. 6. Straight tracing or spiralling has been used in accordance with the wattage input required for the individual pipe runs. Moisture-proof (silicone rubber-covered) heating elements are embedded in the glass fibre covers of these tapes and glass silk thermal insulation and aluminium sheets are applied over the pipes and tapes. To keep the filters, pumps and valves at the same temperatures, complete Isomantles are used. The tapes are applied to the suction side both for the lighting-up section and the load carrying section: the lighting-up comprises six small burners, giving 15 per cent. of the total boiler load. Then the load-carrying burners are put into operation, producing a maximum of 550,000 lb./hr. of steam per boiler. Also the tapes are automatically controlled by thermostats: the bulb is fitted to the outside of the pipe and a capillary leads to the control head which can be set to any required temperature between 80-230 deg. F. Thus compensation for heat losses is provided in a simple and most economic manner. (*Isopad Ltd., Barnet By-pass, Boreham Wood, Herts.*)

Control box for oil-burning equipment

At the recently-held Heating, Ventilating and Air-Conditioning Exhibition at Olympia, Danfoss (London) Ltd. exhibited an interesting range of their automatic controls and equipment. The exhibits included electric motor control gear, controls and hermetically-sealed compressors for refrigeration, compressed-air controls, pumps and nozzles for pressure-jet oil-burners, ignition transformers, thermostats, pressure switches and solenoid valves. The control box, type 57F (shown in the accompanying illustration), which, because of its compactness, safety in operation and simplicity of installation due to its plug-in design has been incorporated by many of the manufacturers of oil fuel burning equipment in the last year, was also featured. Another new exhibit on the stand was the control box type 57G, which is designed for larger oil-burners and air-heaters. It is of plug-in design, and its safety-plus circuit ensures that manufacturers can comply with existing and proposed British Standards, and the most stringent local regulations. [*Danfoss (London) Ltd.*, 13, *Queensway, London, W.2.*]

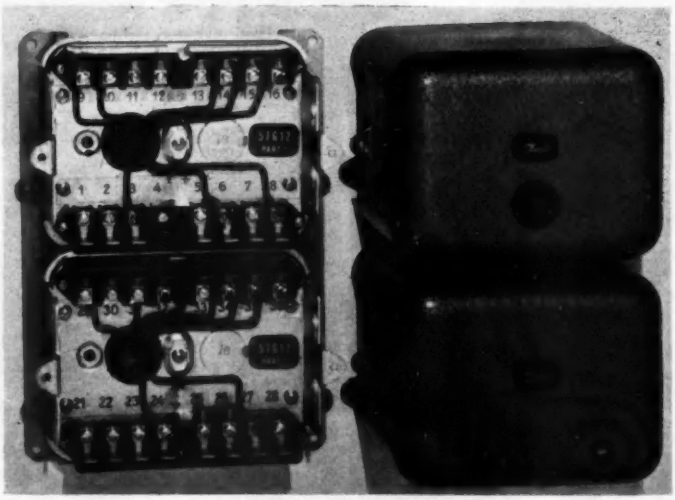


Fig. 7. Control box for large oil burners. [Danfoss (London) Ltd.]

Pipe-end grinding machine

Lingk model "REBS 1" pipe-end grinding machine (Fig. 8) will grind a range of pipes from $\frac{7}{16}$ in. to $6\frac{5}{16}$ in. with a longitudinal grinding surface of up to $9\frac{3}{4}$ in. Other models are also available for grinding pipes with particularly large or small diameters. Attachments for this machine include a swivel vice for gripping very long or heavy pipes, and a device for grinding pipes which are very severely corroded or badly scaled. All Lingk pipe and grinding machines operate on the two-band principle, and are claimed to show a considerable advantage in that they will automatically adapt themselves to the even grinding of all varieties of pipe shapes. The two-band method not only gives smooth, fast grinding and minimum loss of material, but where desired makes it possible to carry out coarse and fine grain grinding simultaneously. (*Roland Goodall Ltd., Station Street, Burton-on-Trent.*)

Fig. 8. Lingk pipe-end grinding machine. (Roland Goodall Ltd.)

Servo control valves

The type VPH control valve has been developed for hydraulic and pneumatic servo duties. It is capable of operating in the pressure range of 250 to 3,000 lb./sq. in. and incorporates $\frac{3}{8}$ in. dia. orifice and $\frac{3}{4}$ in. B.S.P. connections. This valve is available in brass or stainless steel construction and its general design may be seen in the accompanying illustration (Fig. 9). (*Ether Ltd., Caxton Way, Stevenage, Herts.*)

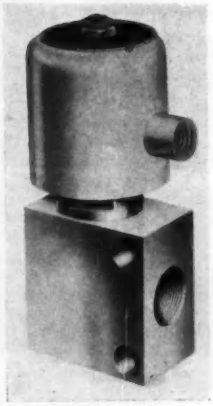


Fig. 9. Type VPH servo control valve. (Ether Ltd.)

Gas blowers for Dungeness

The Heavy Plant Division of Associated Electrical Industries Ltd. is manufacturing the eight gas-blowers to be installed in the C.E.G.B. 550-MW nuclear power station now being built at Dungeness

by the Nuclear Power Group. The blowers, each incorporated in a boiler duct circuit, will circulate the carbon dioxide gas for reactor-cooling. The reactor gas circuit will be pressurised to 300 lb./sq. in. and the gas temperatures at the inlet and outlet of each reactor will be 250 and 410 deg. C. respectively. Each blower, of the single-stage overhung axial-type and driven by an AEI back-pressure steam turbine, will absorb approximately 9,000 h.p. at normal speed and will be capable of dealing with 1¼ tons/sec. of carbon dioxide. The blower casings will be spherical with a diameter of approximately 15 ft. and will have four flanged branch-openings of 6 ft. 6 in. dia. As each blower will be directly below its associated boiler, it is necessary to turn the gas through 180 deg. to ensure the desired gas flow and at the same time conform with the preferred duct arrangement: special guides and fairing arrangements are therefore being provided within the casings. As a safeguard against contaminated gas leaking to the atmosphere, running seals of the oil-fed face type will be situated between the impellor and the first bearing, and a stationary seal arrangement will enable full maintenance—including removal of the main driving shafts—to be carried out without reducing the circuit gas pressure. A two-speed pony motor, rated at 300 h.p., will be incorporated with each unit, in line between the driving turbine and the blower, arranged to drive either at 500 or 1,000 r.p.m. at full gas pressure or at atmospheric pressure respectively. A clutch, built-in with each blower, will automatically prevent reverse gas-flow from driving either the pony motor or the turbine. The driving turbines will operate on the total h.p. steam output from the boilers; after passing out, the steam will be returned for reheating before joining the steam flow to the main turbine generators. Full control of the circuit gas will be obtained by speed variation on the blower turbines; when balanced loads have been achieved, all four units associated with either reactor will be able to be operated by means of a common control system. (*Associated Electrical Industries Ltd., Heavy Plant Division, Crown House, Aldwych, W.C.2.*)

Receipt of an order from the Central Electricity Generating Board, valued at about £325,000, for circulating-water pumping equipment at the new West Burton power station, is announced by **Gwynnes Pumps Limited,** an associate company of **W. H. Allen Sons & Co. Ltd.,** Bedford. The order covers the manufacture, and complete erection of eight Gwynne 78 in. × 80 in. horizontal, double-entry, split-casing centrifugal pumps, each for a duty of 130,000 gal./min., against a total head of 70 ft., and running at approximately 265 r.p.m. They will be driven by English Electric 3,350-b.h.p., 990 r.p.m. squirrel-cage motors through Allen-Stoeckicht epicyclic gear units, which will be built at the Atlas Works, Pershore, Worcestershire, of W. H. Allen Sons & Co. Ltd., Bedford. Also included in the order is suction piping and priming equipment.

* * *

Modernisation of the holding furnaces at **High Duty Alloys Ltd.,** Slough, is being carried out by a completely new method obviating the bricking usually associated with furnace construction and at a quarter of the cost of traditional methods. The furnaces are being converted from oil- and gas-firing to electrical operation. When redesigning them, High Duty Alloys Ltd. looked for a refractory insulation that could be installed simply and inexpensively by their own labour. A material was required that would withstand temperatures of 900-1,000 deg. C. while providing a high degree of insulation. A monolithic concrete made of vermiculite/Ciment Fondu has met all these requirements. This refractory insulating concrete can be mixed and placed in five hours, as compared with three days if bricks are used. It is shaped to hold the electrical heating unit within which the crucible holding the molten alloy is placed. The thickness of the insulation is 7-in. Refractory bricks are cast round the top ledge, to support the steel casing of the heating unit. Forty furnaces have so far been lined with vermiculite/Ciment Fondu, and are in use in the pressure and gravity casting shop.

Turbo-generators and associated plant worth more than £1 million sterling are to be supplied to Australia by **C. A. Parsons & Co. Ltd.,** Newcastle upon Tyne. The State Electricity Commission of Western Australia has ordered from Parsons two 60-MW steam turbo-generator sets, together with condensing and feed-heating plant, for installation in the new Muja generating station. The station is situated on an open-cast coal field near Collie and not far from Bunbury power station where four 30-MW turbo-generators of Parsons manufacture are now in service. These new sets will operate at 3,000 r.p.m. and incorporate turbines of the two-cylinder design. Steam conditions will be 900 lb./sq. in. and 900 deg. F. The generators are rated at 60 MW, 0.8 PF and will operate at 11.8 kV, they will be cooled by hydrogen. All the condensing and feed heating plant will be manufactured at Parsons Whyalla works, South Australia.

* * *

Mr. N. R. D. Gurney, A.C.G.I., M.I.E.E., has recently been appointed general manager of Davy-AEI Automation Ltd. He is also a director of the company. Mr. Gurney was previously Manchester Executive of the Heavy Plant Division of AEI Ltd.

* * *

The General Electric Co. Ltd. has been awarded a contract by the Central Electricity Generating Board, for two 60-MVA synchronous condensers which are the largest machines of this type ordered for service in Great Britain. The contract is valued at about £360,000, and the condensers are to be installed in the Fleet substation, near Aldershot, where they will be used to provide power-factor correction and voltage regulation for the 275-kV supergrid. Both machines will be hydrogen-cooled, and will be transportable with a maximum weight of 110 tons. They will operate from a 13-kV supply and will provide an output variable over a voltage range of +15 per cent. to −10 per cent. when running at 1,000 r.p.m. The condensers are scheduled to be in operation in 1963.

Honeywell Controls Ltd. have received orders for process control instrumentation totalling £250,000 for use at the new integrated Spencer steelworks of Richard Thomas and Baldwins Limited, near Newport, Mon. Much of the installation will be carried out by Honeywell. Temperature, flow, pressure and oxygen-analysing equipment will be supplied for reheating and heat-treatment furnaces being installed by Priest Furnaces Limited, Stein and Atkinson Limited, and Incandescent Heat Co. Ltd., respectively. Instrumentation is also being installed by Honeywell for lime kilns, ore-dryers, pickle line, acid recovery and other plant, mainly on direct order from R.T.B.

* * *

Increasing use of modern tower cranes for building construction has focused attention on the need for reliable and positive safety devices to prevent overloading of the crane, and for convenient indicators to give advance warning of excessive load or radius. The Simcox safe-load indicator, and constant-load limiter are separate units which operate with a common visual warning, audible alarm, and cut-out. Together, they form a complete system that gives full protection. Specially-developed by the Materials Handling Division of **Babcock & Wilcox Limited** for inclusion as standard equipment on the British-built Babcock-Weitz saddle-jib tower cranes, and for application to all Weitz tower cranes imported into this country, they can be adapted for use on other types of tower crane. These units operate automatically and are designed to meet the Ministry of Labour's Building (Safety, Health and Welfare) (Amendment) Regulations, No. 1553, 1958, which require safe-load indicators to be fitted to cranes used on building sites. The Simcox safe-load indicator is mounted on the main tie-bar that supports the jib by linking it to the top of the tower. It safeguards the crane against excessive loads and/or radius. Wired in parallel is the Simcox constant-load limiter, which is embodied in one of the hoist-rope pulleys, and provides protection against excess loads

on the hoist-rope, irrespective of the radius. Both units include mechanical means for operating micro-switches which, as the safe working load is approached, give a preliminary visual warning and then an audible alarm before tripping the control circuits to safety. After tripping has occurred, no outward travel of the crane's saddle or raising of the load is possible, but inward travel and/or lowering of the load can still be effected by the normal controls. As soon as the excess of load or radius is removed, all circuits are restored for normal working by use of the "start" control. Operation of the safe-load indicator is based on a continuous comparison between the length of the loaded tie-bar and the constant length of an unstressed operating rod. The normal setting of both items is for visual warning at 85 per cent. and audible alarm at 95-97 per cent. of the safe working load, and the circuit-trip is set to operate when the safe working load is exceeded by a predetermined amount. The common alarm unit, containing the warning light and alarm bell, is fitted in the crane's control cabin or other control station. The complete equipment is stated to afford unvarying performance during long periods of use.

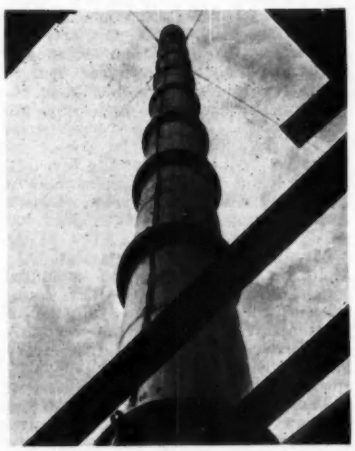
* * *

One of the most important of Britain's industrial developments in the metallurgical field during recent years, is the establishment of the new works of **Henry Wiggin and Co. Ltd.** at Hereford. This plant represents the culmination of the company's modernisation and concentration plan which is scheduled for completion in 1965. Henry Wiggin and Co. Ltd., have, for more than 40 years, engaged in exporting nickel and nickel alloy products to nearly all countries in the world. During the past 15 years they have concentrated increased efforts on expanding their export shipments. Recently, the company brought 20 of their overseas agents (representing 13 different countries) to Britain to view for the first time the plant, which on completion will, it is claimed, be the largest and most modern of its kind in the world, comprising 25 acres of buildings on a total site area of 52 acres. The visitors made a complete tour of the plant and laboratories, and in addition to talks by the chairman, the managing director, the sales director, and other sales executives, they saw an exhibition featuring applications of corrosion-resistant materials which represent one of the three main types of specialised alloys produced by the company. Another is the Nimonic series of high-temperature materials which are world famous in their aeronautical application. In addition, there are a number of special alloys produced by the company which have special physical properties that play an important part in the electronics industry. A feature of all the high-nickel alloys produced by Henry Wiggin & Co. Ltd. at their Hereford works is the rigid process control exercised at every stage of their manufacture. The most modern metallurgical methods of testing are employed to ensure their consistently high quality.

Samuel Fox and Co. Ltd., a subsidiary of **The United Steel Companies Ltd.**, announce an addition to their Jethete range of high-strength stainless-steels for elevated temperature service. Known as Jethete M153, it is a 12 per cent. Cr-Ni-Mo composition with higher impact properties and better ductility than Jethete M152. It has been developed for structural applications where the high strength of Jethete M152 is not called for, and this has been achieved by the elimination of vanadium and a lowering of the molybdenum content, thus improving the hot workability and also enabling a small price reduction to be made. Jethete M153 is now commercially available in the form of billets, blooms and slabs for forging or re-rolling, and bars and turned rounds for machining or forging. A technical data sheet on Jethete M153 is available on request to the compound at The Mount, Broomhill, Sheffield 10.

* * *

To meet the requirements of the Clean Air Act concerning a new sulphuric acid plant at the Stratford, London, factory of F. W. Berk & Co. Ltd., it was necessary to build the steel chimney to a height of 150 ft. (illustrated below). To avoid the heavy cost of periodic painting and possible early replacement of upper sections of the chimney exposed to acid dewpoint conditions, it was decided to protect the upper part of the chimney with a coating based on Geon P.V.C. The coating



operation was carried out by Plastic Coatings Ltd., Guildford. Sections of the 30 in. dia. chimney were immersed in a tank containing a paste based on Geon 121 resin, thus coating both sides and flanges. When gelled, the paste forms a smooth abrasion resistant coat with excellent adhesion to the metal. The coat is not affected by weather, and requires no form of maintenance, while being corrosion resistant it protects the interior of the chimney from the acidic conditions of the plant. Geon 121 P.V.C. paste resin is manufactured by **British Geon Ltd.**, a company in the Distillers Plastics Group.

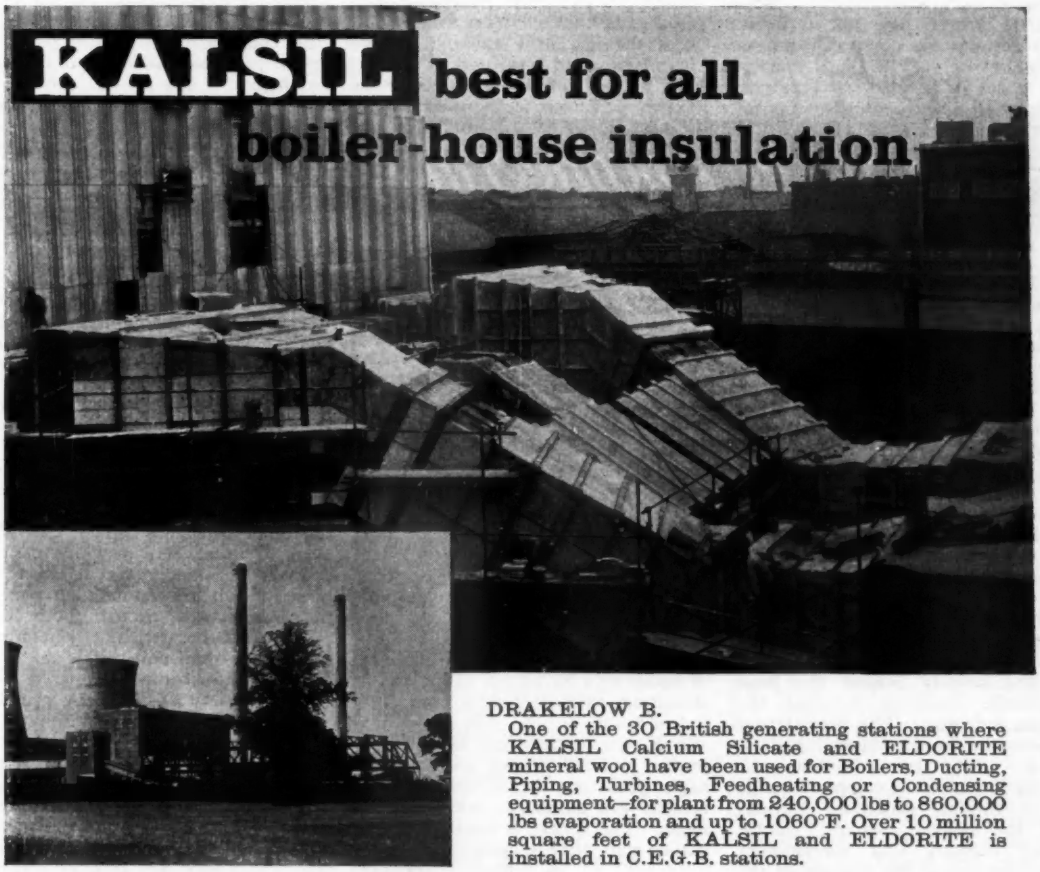
A contract for the supply of chemical plant, the cost of which will be approximately £250,000 for the Dyestuffs Division of Imperial Chemical Industries Limited, has been awarded to **John Thompson (Wolverhampton) Limited,** the founder member of the John Thompson Group of Companies. The company besides being well known for shell-type boiler design and manufacture for over 130 years, has also been responsible for considerable work in the pressure-vessel field of chemical engineering. Other John Thompson Group Companies have also had much experience in the design and manufacture of chemical plant, and therefore, in order to concentrate these design facilities into a specialist organisation, a Chemical Plant Design and Construction Engineering Division has been established by John Thompson (Wolverhampton) Limited at the company's main works at Ettingshall. The newly-formed divison is able to offer facilities for effecting the complete plant contract, including mechanical, electrical and civil work, from initial design, to the final erection and commissioning. The contract for I.C.I. Dyestuffs Division comprises extensions to an existing intermediate plant, and includes vessels ranging from 50 gal. to 2,000 gal. capacity, suitably lined whereever required. Other components include pumps, weighing and drum-filling devices and drying equipment, together with pipework, supports and valves, electrical switchgear, instrumentation and controls. The plant is scheduled for commissioning early in 1963.

* * *

Simmonds Aerocessories Limited, Treforest, Glamorgan, a member of the Firth Cleveland Group and the leading manufacturer of specialised fasteners—Nyloc and Pinnacle Self-Locking Nuts, Simmonds Weld Nuts and Spire Speed Nuts—and a wide selection of standard and cold formed nuts, have now moved their Birmingham Midland Area Sales Office from Lancaster House, Newall Street, to new and larger office accommodation at Herbert House, Cornwall Street. The existing Telex numbers 33-312 and Birmingham Central 2248-9 telephone numbers have been retained, and a third telephone line, Birmingham Central 2719, has been added. Simmonds products for the Midland Area are marketed under the direction of **Mr. A. H. Patterson,** Midland Area manager for the Nut and Bolt Sales Division, and **Mr. K. E. Amos,** assistant sales manager for the Spire Speed Nut Division.

* * *

Sulphamic acid is now being supplied by **Albright & Wilson (Mfg.) Ltd.,** from the first plant in the U.K. to produce in bulk. As the only crystalline strong acid in existence, sulphamic acid has many advantages over liquid acids, while retaining all the essential properties. Its most important advantages are the ease with which it may be transported and stored; the absence of vapour, even when heated, and safety in handling. Sulphamic acid has many and varied uses in a wide range of industries. It is particularly valuable as a universal cleaner and descaler of metals.



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One of the 30 British generating stations where KALSIL Calcium Silicate and ELDORITE mineral wool have been used for Boilers, Ducting, Piping, Turbines, Feedheating or Condensing equipment—for plant from 240,000 lbs to 860,000 lbs evaporation and up to 1060°F. Over 10 million square feet of KALSIL and ELDORITE is installed in C.E.G.B. stations.

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OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

Nuclear power station at Indian Point

In the last issue we referred to the two Foster Wheeler separately-fired superheater units being installed for the Indian Point (U.S.A.) nuclear steam electric generating station to be operated by the Consolidated Edison Company of New York. We now publish some details concerning the design of the complete station, which is located at Buchanan on the east bank of the Hudson River, 24 miles north of New York City. Distinctive external features of the plant are the dome-shaped structure containing the reactor and boiler sections and the 400-ft. high chimney installed directly behind the large rectangular building housing the turbine generator. The plant layout is shown in the accompanying illustration. The layout follows the manner in which the company builds its conventional generating stations with the nuclear reactor, reactor service building and containment sphere occupying the position of the usual h.p. boiler and its auxiliaries. This nuclear station is planned as the first part of a major generating station development, of up to possibly 3,000-MW capacity. Thus succeeding units of this development could be either of the nuclear type or have a conventional, high-pressure steam boiler. As may be seen in the illustration there are five principal structures of the nuclear portion of the plant. These are: (1) safety containment vessel; (2) external radiation shielding; (3) the reactor service building; (4) fuel handling building, and (5) waste disposal building (at the rear of the fuel handling building). The safety containment vessel is provided to eliminate the possibility of dispersing any significant amount of radioactivity over the area serving the station. The vessel is designed to withstand a maximum internal pressure of about 27.5 lb./sq. in. gauge and a maximum external pressure differential of 1.0 lb./sq. in. The vessel is a 160 ft. dia. sphere and houses the nuclear reactor proper and all the high pressure, high temperature coolant and auxiliary system equipment. The sphere is constructed of carbon steel plate approximately $\frac{7}{8}$-in. thick. Suitable penetrations for electrical, steam, instrument, water and ventilation lines are provided, besides a 50-ton gantry crane for handling equipment. The selection of equipment for installation inside the sphere and the shielding requirements of this equipment have been based on the fact that there will be no access into the vessel when the reactor is operating. The external radiation shielding consists of a concrete wall and concrete roof serving the containment vessel which is partly below ground and serves as the outer biological shield. In the event of an accident in which fission product substances are released in quantity into the containment vessel, the shield will protect both the public and the personnel operating this and adjacent units. The shield is constructed of ordinary concrete 5½-ft. thick up to 65 ft. above ground with the completely self-supported trussed roof having a thickness of 2 ft. 9 in. The four storey reactor service building is situated adjacent to the west side of the external radiation shield wall and contains offices, laboratories, counting rooms and certain auxiliary systems equipment. The fuel handling building, located adjacent to the east side of the external radiation shield wall is used to store and deal with both new and used fuel elements and controlled elements. The reactor core is an internal thorium converter. It is cooled, moderated and reflected by pressurised light water and operates in the thermal neutron range. The reactor utilises fully-enriched uranium as the base fuel in the form of uranium oxide, and thorium oxide as the fertile material. The two

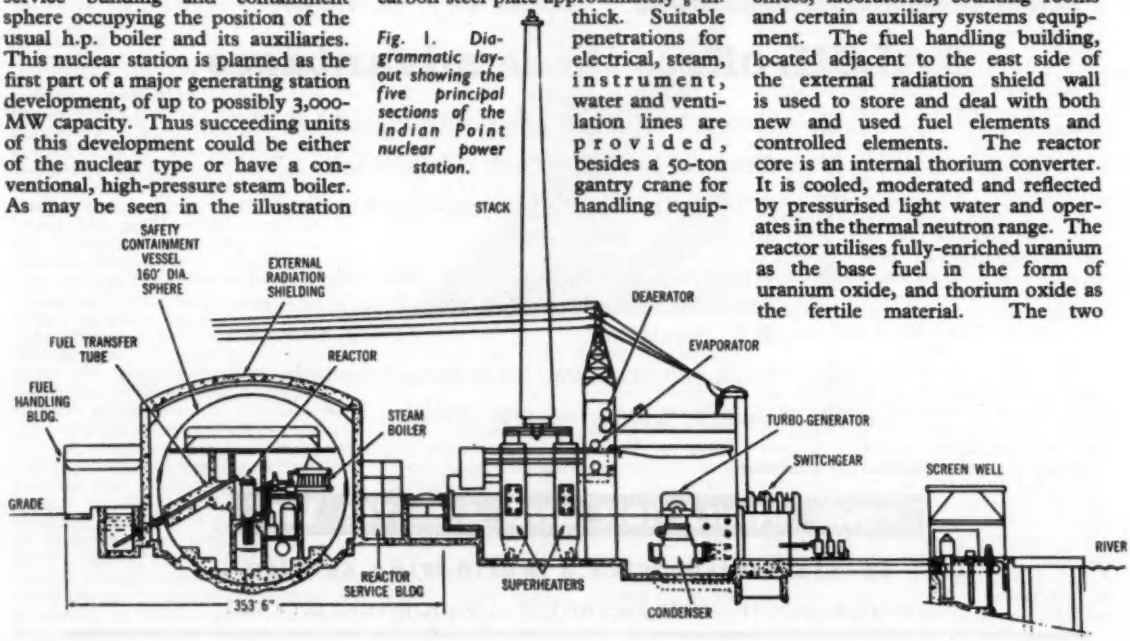

Fig. 1. Diagrammatic layout showing the five principal sections of the Indian Point nuclear power station.

materials are homogeneously mixed, formed into pellets and incorporated in rod-type fuel elements clad with stainless steel. The reactor operates at 1,500 lb./sq. in. and is cooled by the circulation of water in four coolant loops operating in parallel. About 131,700 gal./min. of coolant enter the reactor at 485 deg. F. and leave at 517 deg. F. The reactor and its auxiliaries are designed for a thermal capability of 585 MW and will produce 2,200,000 lb./hr. of saturated steam at 405 lb./sq. in. and 449 deg. F. The first core, composed of 120 fuel elements, will have an expected life of approximately 600 full power days. The turbine is a tandem-compound, double-flow, 1,800-r.p.m. machine with an estimated gross operating capacity of 275 MW. Steam will be discharged to a two-shell, single-pass condenser having a cooling area of 212,000 sq. ft. The condenser has 24 sampling points to detect leakage and provision is made for overboarding. Three feed-water heaters in series with a de-aerator and including economiser sections for the superheaters between the second and third feed-water heaters will raise the feed-water temperature to 332 deg. F. (*Heat Engineering*, Vol. 36, No. 4, July-August, 1961, pp. 58-9.)

Non-reheat plant superior for peak-load installation

When fixed charges are taken into account, a non-reheat peak-load installation in U.S.A. has proved more economical than a reheat unit would have done. The plant in question is the Arsenal Hill Unit No. 5 of the Southwestern Electric Power Company, to which some reference was made in our two previous issues. The turbine, by General Electric, is a 3,000-r.p.m., 100-MW tandem compound, double-flow, non-reheat design. Steam conditions are 1,450 lb./sq. in. and 1,000 deg. F., with an exhaust pressure of 3½ in. Hg. abs. A feature of the turbine is the provision for full-arc admission, which allows a shorter starting period with minimum thermal stress to the high pressure shell and block. (The system of matching steam and turbine temperatures for this plant was described in our October issue.) The Combustion Engineering boiler is a tangentially-fired, gas-burning unit, rated at 810,000 lb./hr. with final superheated steam conditions of 1,500 lb./sq. in. and 1,005 deg. F. The superheater arrangement was designed so that all of the superheater elements and the headers can be completely drained. Total investment cost of this installation, including the power transformer, reservoir, land and offices was $10,130,000. If the summer rated capacity is used as a basis, an initial investment cost of $87.33 per kW of capability is shown. This figure is slightly higher than the company's previous investment cost per unit figure; but at the same time it is stated to be about $13 per kW of capability cheaper than a reheat, baseload unit would have been, had the reheat machine been purchased at the time that Unit No. 5 was purchased. Fixed charges on all of the units amount to around 14 per cent. of the total investment cost per year. During 1960, Unit No. 5 had a yearly load factor of 9.19 per cent. and generated at a total of 90,783,900 kW-hr. The fixed charges per net kW-hr. on Unit No. 5 compared with an equivalent reheat unit operating at the same load factor have proved to be in a ratio of 1 : 1.13 (15.62 : 17.65) in its favour. (*Power Engineering*, Vol. 65, No. 9, September, 1961.)

Czechoslovak blast-furnace gas/coal-fired boiler

Research into the problems of operating a slag-tap furnace, 473,000-lb./hr. boiler suitable for firing mainly by low-grade high ash-content coal and with auxiliary burning of blast-furnace gas, has been necessitated by a recent metallurgical works installation in Czechoslovakia. Electric power for the works will be met by a centralised heating plant involving a considerable number of these 473,000 lb./hr. (215 tons/hr.) boilers with an output of superheated steam at 1,470 lb./sq. in. (100 atm.) and 540 deg. C. The coal has a high calorific value of 11,500 B.T.U./lb. (6,450 k.cal./kg.), but it is poor in volatile matter (12 per cent.) and with ash of a low softening point (1,030 deg. C.), which can easily be tapped in a molten (1,150-1,230 deg. C.) or fluid (1,260 deg. C. max.) state from the furnace. The blast-furnace gas is surplus from the plant, is of low calorific value of 102 B.T.U./cu. ft. (910 k.cal./cu. m.), and in quantity will vary considerably during the year. This last point thus necessitates some form of gas-pressure control in the gas control system, burning more gas as the pressure increases and limiting or stopping completely the burning of gas as the pressure falls. For ignition and maintenance of stable combustion of the coal-dust at lower outputs, heavy fuel oil of 300 sec. Redwood No. 1 (10 deg. Engler) will also be burned. Tests with various forms of boiler and coal firing confirmed that slag-tap operation was by far the most suitable for the given type of coal in spite of all the technical and economic difficulties of auxiliary burning of blast-furnace gas. The most difficult problem arises because the fusion process involves the use of high temperatures in the furnace. The combustion temperature of the above-mentioned coal is about 1,650-1,750 deg. C.; that of the blast-furnace gas is about 1,200 deg. C. If the blast-furnace gas burners are introduced into the fusion space, the temperature in the furnace drops considerably, thereby rendering the topping of slag more difficult. Another problem from this combined fuel burning is from the higher percentage of unburnt components in fly ash and consequent increase in losses due to poor combustion. A third problem adding to the difficulties is that the flame radiation drops with the increasing proportion of burnt blast-furnace gas, thus decreasing the amount of heat transmitted from the flame through radiation to the boiler heating surfaces while the outlet flue gas temperature

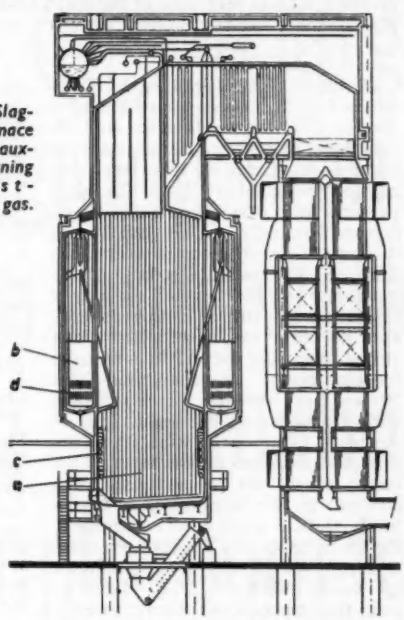

Fig. 2. Slag-tap furnace boiler for auxiliary burning of blast-furnace gas.

rises. These disturbing combined combustion effects are overcome by the design shown in the accompanying illustration. The coal-dust is burned by the fusion process in an open slag-tap furnace (*a*) while the blast-furnace gas is consumed in separate combustion chambers (*b*) arranged on the front and rear walls of the coal-dust furnace of the boiler, the gas burners being located at (*d*). The melting space of the coal-dust furnace is partially separated from the cooling space by a throttle system consisting of the front and rear wall tubes of the cooling nest. The throttle system has a beneficial effect on the development of high temperatures in the slag-tap furnace and ensures efficient melting of the slag and burning of coal with a low content of volatiles. The coal-dust burners (*c*) are located in the corners of the furnace and comprise the respective nozzles for supply of the coal-dust and primary air mixture together with nozzles for the secondary air and vapours, and holes for inserting ignition oil burners. (*Czechoslovak Heavy Industry*, No. 11/1961, pp. 31-33.)

Hawker Siddeley Brush Turbines Ltd. have been awarded a contract by Constructors John Brown Ltd. for three axial-flow compressors to supply compressed air for a large tonnage oxygen plant in Poland. The compressors will be electrically-driven (approximately 6,000 h.p.) and delivery of the first compressor set is due in December, 1962. The machines are the first of their type to be manufactured in this country and the first to be supplied by a British company for use in a tonnage oxygen plant. Constructors John Brown are working in association with Hydrocarbon Research Inc. of America, who are supplying the process techniques for the plant. This order follows the recent award of a contract by the National Coal Board for a similar axial-flow compressor, driven by an H.S.B.T. steam turbine, to supply compressed air to collieries in South Wales. The H.S.B.T. axial-flow machine—a new venture for the company—incorporates advanced design features in its blading, seals and bearings, and the method of construction enables H.S.B.T. to offer a wide range of compressors using standard components. Welded construction has been used wherever possible to keep down manufacturing costs and for early delivery. (*Hawker Siddeley Brush Turbines Ltd., Duke's Court, Duke Street, London, S.W.*1.)

A £4 million order to supply two 350-MW steam turbines for the Munmorah power station, New South Wales, Australia, which will be the largest in the southern hemisphere, has been awarded to **The English Electric Co. Ltd.** by the Electricity Commission of New South Wales. The first machine is scheduled to go into commercial operation in November, 1966, and the second a year later. The two 3,000 r.p.m. single-line reheat steam turbine generators will be the most powerful to be installed in Australia, and are similar to the 350-MW units now on order from English Electric for the C.E.G.B. Drakelow "C" and Blyth "B" power stations. The Munmorah station, to be built between Lake Munmorah and Lake Budgewoi, will be about 10 miles distant from the Vales Point power station, for which English Electric are supplying three 200-MW units. The site of the new station was chosen because of the vast coal deposits in the area, and the ample supply of cooling water from Lake Munmorah. The sets will be made at the company's Rugby works. The new machines will operate with turbine stop-valve steam conditions of 2,300 lb./sq. in. and 1,050 deg. F., with reheat to 1,000 deg. F. Final feed temperature at C.M.E.R. will be 485 deg. F.

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G.E.C. (Engineering) Ltd., of England, has received an order from Millspaugh Wimpey Ltd. for a 7-MW double-passout condensing turbo-generating set for installation in a pulp and paper mill at Plaksi, Yugoslavia. Valued in the region of £130,000, it forms part of a £3 million contract which Millspaugh Wimpey Ltd. has received for plant for the same mill. Turbine steam conditions will be 554 lb./sq. in. at 824 deg. F. with vacuum conditions of 28.75 in. Hg. Pass-out will be controlled at 185 lb./sq. in. and 45 lb./sq. in., the quantities of steam at these pressures being 17,630 lb./hr. and 79,370 lb./hr. respectively. The 3,000 r.p.m. turbine will be direct-coupled to an 8.75 MVA, 10 kV, three-phase generator.

* * *

Two circulating-water pumps for the latest extension to the Grandpass Power Station, Ceylon, have been ordered by the English Electric Co. Ltd. from **W. H. Allen Sons & Co. Ltd.** The pumps are "Allen-Stork" 2 in. vertical-spindle suspended mixed-flow diffuser casing units, driven by 185 h.p. English Electric motors. Each pump will deliver 12,383 gal./min. for condenser cooling. Two similar units were recently delivered for the first part of the power station. Consulting Engineers are Messrs. Preece, Cardew & Rider. Another order is that placed with the company by John Thompson Water Tube Boilers Ltd., for an additional circulating-water pump for the Dekhelia Power Station, Cyprus. The pump is a 31-in. vertical-spindle single-suction centrifugal unit of 16,000 gal./min. capacity, driven through an Allen-Stoeckicht epicyclic gear by a 140 h.p. AEI squirrel-cage motor. Four identical units were supplied between 1950 and 1957. The third order has been awarded by the Electricity Supply Commission, South Africa, to **Dowson & Dobson Ltd.**, Johannesburg, agents for W. H. Allen Sons & Co. Ltd., and is for a circulating-water pump for the West Bank Power Station "B" extensions, in East London, Cape Province. The pump is to be an Allen 30 in./27 in. vertical-spindle centrifugal pump, complete with a 200 h.p. driving motor and associated valves, pipes and auxiliary equipment. Manufacture of this pump will be carried out in South Africa to designs supplied by W. H. Allen Sons & Co. Ltd. It is estimated that 90 per cent. of all the equipment covered by the contract will be manufactured in the Republic. Consulting engineers for the power station are Messrs. Merz & McLellan.

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Cambridge Instrument Co. Ltd. and **Instrumenti di Misura C.G.S., S.p.A.**, Monza (Milan, Italy), announce final agreement for the formation of a new joint company, Cambridge-C.G.S.-S.p.A. The issues capital of the new company, in which each parent organisation has an equal interest, will be 300 million lire, official permission having been given for the remittance of the Cambridge contribution. The factory will be located at Casoria, near Naples, adjoining an existing production plant of Instrumenti di Misura, C.G.S. Cambridge-C.G.S. will initially manufacture instruments based on Cambridge designs, including electronic and galvanometric indicators and recorders for a wide range of applications, and associated control equipment. These will, where necessary, be adapted to meet the requirements of the Italian and neighbouring markets. The distribution function will be in the hands of C.G.S. and Soc. Ing. Taragni & Co., the latter having for many years acted as agents for Cambridge in Italy. The board of Cambridge-C.G.S. will comprise the president of Istrumenti di Misura, C.G.S., **Ing. G. Bauchiero**; the chairman of Cambridge Instrument Co. Ltd., **Dr. P. Dunsheath**, C.B.E., D.Sc., LL.D.; **Ing. L. Bosisio, Mr. H. C. Pritchard**, B.A., F.R.Ae.S., **Rag. Emanuele Luini**; and **Mr. W. E. Lamb.** The first President of Cambridge-C.G.S. will be **Ing. G. Bauchiero.**

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An Anglo-American Production and Marketing Agreement for a new range of hydraulic control valves has been concluded between **Dowty Hydraulic Units Ltd.**, Ashchurch, Gloucestershire, **Rubery Owen and Company Ltd.**, Darlaston Staffordshire and the **Hydraulic Units Specialties Company**, of Waukesha, Wisconsin, U.S.A. In the agreement, the full range of Husco Valves, at present manufactured in America by Hydraulic Units Specialties Company, will be produced in this country by Rubery Owen and Company Ltd. They will be marketed in Britain and throughout Europe by Dowty Hydraulic Units Ltd., as the Dowty-Husco range. One hundred and twenty combinations of the valve will be available in sizes up to 158 imperial gal. per min.

The new Richardsons Westgarth Maxecon* three-pass, wet back shell boilers have.... a large steam release area, giving high-purity steam.... a large water volume for handling fluctuating loads.... and ample room for internal examination.

Steam Dryness Fraction is 0.97 +, and Steam Purity 1.75 p.p.m. at full rating with boiler water T.D.S. 2250 p.p.m.

The boiler's flexibility is such that during development tests the load was increased from zero to M.C.R. in two minutes without any significant drop in boiler pressure.

All three passes are well submerged, the two combustion chambers being set at an angle to allow the third pass to run between them. This design leaves ample room for internal inspection, yet the whole boiler takes up only three quarters of the floor space needed by an equivalent dry back boiler. *Further particulars available on request.*

Thermal Efficiency : High thermal efficiency over a wide range of loads.
Pressure : Up to 250 p.s.i.g.
Capacities : 11,000 lb/hr. to 23,000 lb/hr. (Designs to extend this range are under development).

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Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Valve for feedwater regulators, etc

This invention relates to plant of the type that includes both a boiler or similar vessel, e.g. an evaporator and an auxiliary chamber that houses a level controller, a feedwater regulator or an alarm mechanism and that is connected to the vapour and liquid spaces of the vessel. In such a plant it is important that the chamber should be blown down periodically in order to remove deposited solids which might interfere with its operation. The connections between the vessel and the chamber, which may be called the vapour and liquid legs respectively, are usually valve-controlled pipes, and a valve-controlled blowdown pipe which discharges to waste is connected to the bottom of the chamber. This blowdown pipe is often the head of a "T," the liquid leg being the stem of the "T" and joining the blowdown pipe upstream of the valve in it. In normal operation, the valves in the vapour and liquid legs are both open, and the blowdown valve is closed. The sequence of operations on blowdown is to close the valve in the liquid leg, open the blowdown valve so that the liquid and suspended solids in the chambers are discharged to waste and subsequently vapour from the vessel passes through the chamber to scour it and pass to waste, open the valve in the liquid leg so that this leg is flushed by liquid which also runs to waste, and finally close the blowdown valve to restore the whole system to its normal running state. In practice it sometimes happens that the operator forgets to open the valve in the liquid leg after blowing the chamber down, so that only the vapour leg is open to the vessel. The result is that the regulator or alarm ceases to operate properly and the effect may be disastrous. According to this invention, a single rotary multi-position valve controlling the liquid leg and blow-down pipe is provided, and is connected to and preferably operated through a ratchet mechanism or other one-way device so that it must pass through a position in which the chamber is blown down and another in which the liquid leg is blown down before it can re-enter its starting or normal position. During blowing down there is discharge of liquid and vapour through the blowdown pipe, and this inevitably calls the attention of the operator to the fact that blowing down is still proceeding, and he cannot restore it to its normal position without completing the cycle of movements. The valve is preferably of the kind in which a rotary plug having internal passages lies within a casing having ports inter-connected by the passages. Referring to Fig. 1, a boiler plant includes a boiler (1), an auxiliary chamber (2) containing a feedwater regulator, a steam leg constituted by a pipe (3) controlled by a valve (4) and connecting the steam space of the boiler to the chamber (2), a pipe (5) extending downwards from the bottom of the chamber (2), a water-leg constituted by a short pipe (6) running from the water space of the boiler, a blowdown pipe (7) discharging the waste, and a valve (8) controlling the flows from the pipes (5 and 6) to the blowdown pipe (7). Referring to Figs. 2 and 3, the valve (8) includes a casing (9) having two bores at right-angles to one another, thus providing four ports (10, 11, 12 and 13), and a plug (14) controlling these ports. In normal operation of the boiler, the plug (14) is in the position shown in Fig. 3 in which the steam and water legs are connected to one another through the chamber (2). When the chamber (2) is to be blown down, the operator first turns the handle (20) through 90° to bring the plug into the position shown in Fig. 4, in which the water-leg is closed and steam flows through the chamber (2) to blow it down and carry solids away through the pipe (7). Next, the handle is turned through a further 90° to close the steam-leg and open the water-leg as shown in Fig. 5, the water-leg thus being flushed by water which also passes through the pipe (7). The handle is then turned through another 90° to bring the plug into the position shown in Fig. 6, in which both the chamber (2) and the water-leg (6) are connected to

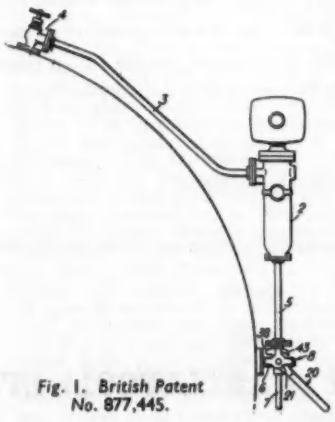


Fig. 1. British Patent No. 877,445.

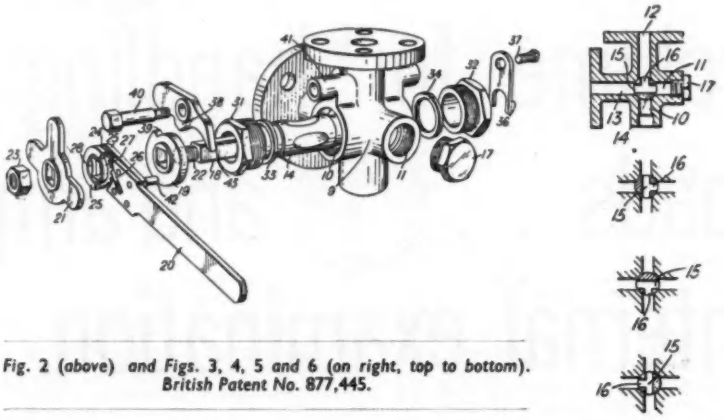


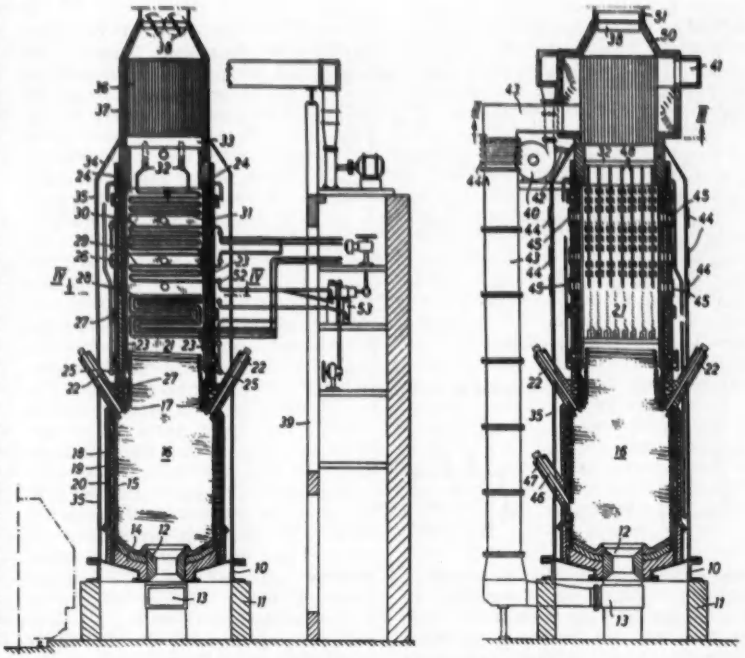
Fig. 2 (above) and Figs. 3, 4, 5 and 6 (on right, top to bottom). British Patent No. 877,445.

the pipe (7). The operator may, if he wishes, turn the handle straight through this position to bring the plug into the position shown in Fig. 2 and thus complete the circle. *British Patent No. 877,445 issued to Ronald Trist & Co. Ltd. Complete specification published September 13th, 1961.*

Forced-draught boiler

This invention relates to a forced-draught boiler in which the products of combustion pass through the boiler in a direction axially of the furnace chamber and thence through a tubular air-heater forming a straight line continuation of said chamber.

Referring to Fig. 7, the boiler is carried on a supporting ring (10) resting on a concrete foundation (11). Built into the floor of the furnace is a burner (12) which is supplied with the necessary combustion air through a duct (13). The tube lining (15) of the furnace chamber (16) is supported on the bottom layer (14) of the floor structure of the furnace. The tube lining (15) may consist of a helical coil comprising several parallel tubes, or of parallel sinuous groups of tubes, extending to and fro. Towards the top of the furnace chamber (16) its cross-section is narrowed as shown at (17), the tube lining (15) of the chamber extending beyond this constriction. Conveniently, the cross-section may at this point be modified to assume an angular, such as a square shape. On the outside of the tube lining is a refractory layer (18), for instance of firebrick, and this is enclosed within a gas-tight sealing sheet-metal shell (19) which completely surrounds the furnace chamber (16) and the uptake (21). The outer face of the sheet-metal shell (19) is lagged with a heat resistant material (20), such as absestos, slag or glass wool, of appropriate thickness, which may be supported by a wire mesh or suchlike. Observation tubes (22) are provided at the zone (17) where the cross-section narrows. These tubes are welded to the thin sheet-metal shell (19) and permit the flame formation inside the furnace chamber to be observed. The walls of the uptake consist of vertical flat walls of tubing (23) communicating with headers (24, 25, 26). Above the zone (17) where the cross-section of the furnace chamber narrows, the thin sheet-metal shell (19) is provided with an appropriate number of corrugated expansion elements (27) to permit the shell to adapt itself to the thermal expansions of the walls of the furnace chamber (16) and of the uptake (21). In conventional manner, the uptake (21) contains the contact heat transfer surfaces (28 to 31). The upper headers (32), with which the



Figs. 7 (left) and 8 (right). British Patent No. 877,665.

economiser (31) is connected, are movably suspended from a cross beam (33) resting on the reduced upper-end (34) of a supporting external shell (35) of the boiler. The cross beam (33) also pendantly supports the upper headers (24) of the tubes (23) which form the lateral walls of the uptake (21). Resting on cross beam (33) is an air-preheater (36), the furnace gases passing straight through it. Preferably, the preheater has an external lagging (37) which may be provided with an outside sheet metal skin or suchlike. Above the preheater are dampers (38), and the whole is surmounted by a chimney (51). If the boiler is erected outside it is advisable in any event to place it near an adjacent building (39) to permit the controls, the superheated steam-cooler, the air blower, etc., to be installed for protection inside the building. Fig. 8 is a sectional elevation of the boiler at right-angles to that shown in Fig. 7. A blower (40) forces fresh air into a draught-box (41). At the same time, fresh air at the static pressure of blower (40) is forced through a branch (42) into the space inside the supporting sheet-metal shell (35). Consequently, the pressure inside this space will, throughout, be a little higher than in the furnace chamber (16) or in the uptake (21). Slight pressure losses inside the shell are compensated by the blower (40) through branch (42) so that the static pressure inside the sheet-metal shell (35) will be maintained. The preheated combustion air reaches the burner (12) through a thermally-insulated duct (43) including expansion elements (44A). The external shell (35) is fitted with several entry doors (44) which close in a gas-tight manner and which are located opposite entry doors (45) in the walls of the gas uptake (21). For the purpose of observing the burner opening, an additional observation tube (46) is provided at an appropriate height. This tube, in the same way as the other observation tubes (22), projects from a tubular socket (47) welded to the external shell (35) and has sufficient frredom to adapt itself to the thermal movements of the wall of the furnace chamber (16). It will also be seen in Figs. 7 and 8 that the contact tube bundles (29 to 31) and the superheater (28) are suspended from cooled fall tubes (48). *British Patent No. 877,665 issued to Walther & Cie A.G. Complete specification published September 20th, 1961.*

Steam generator with reheater

The aim in starting up, in the case of a steam generator comprising an interstage superheater, is to get up steam in the boiler with the shortest possible delay. This presents the problem of cooling the interstage

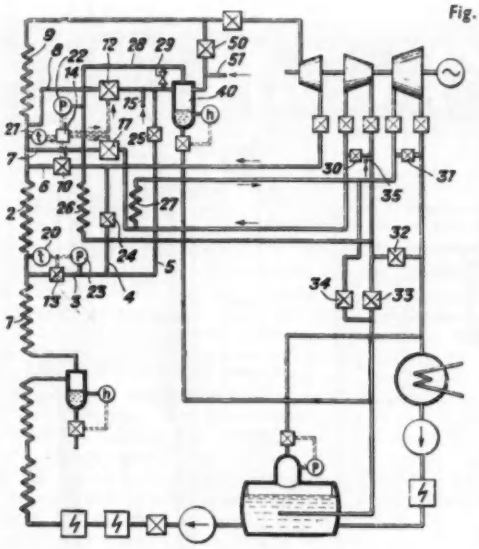
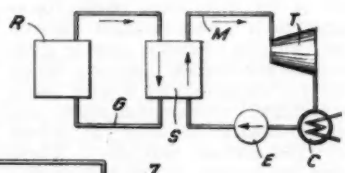
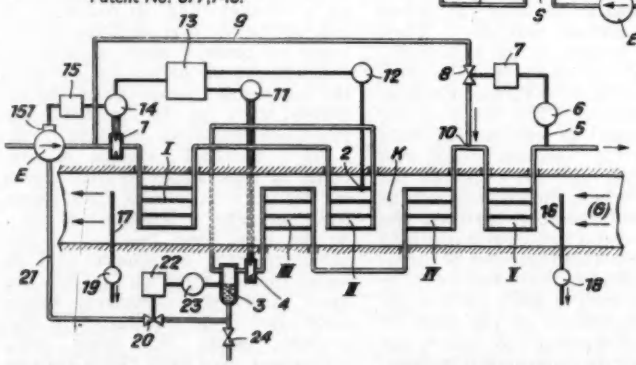


Fig. 9. British Patent No. 877,706.

superheater as rapidly as possible, without causing the presence of condensed working fluid in the pipes leading to the turbines, at least towards the end of the starting up operation. The task thus consists of obtaining the working fluid utilised to cool the interstage superheater in the form of superheated steam in the shortest possible time at the outlet of the superheater, even during starting up. It has hitherto been the practice to draw off working fluid during starting up for the purpose of cooling the interstage superheaters, but only at the end of the superheaters. In the method covered by this patent, at least a part of the working fluid is drawn off in stages from different sections of the superheater according to the local temperature in these sections. This working fluid is at least partially used to cool the interstage superheater or superheaters. If several interstage superheaters are provided, it is, in certain conditions, also possible to cool only one of these, depending on their spacial disposition. Referring to Fig. 9, pipes (3, 6, 7 and 8) branch off between different superheater sections (1, 2 and 9) in order to apply the method according to the invention. The pipe (3) branching off between the superheater sections (1 and 2) forks downstream of a shut-off valve 13 into branches (4 and 5) which are fitted with valves (24 and 25) respectively. The branch (4) leads directly into the first interstage superheater (26), whereas the branch (5) leads into a by-pass water separator (40). A pipe (28) connects the separator to the inlet of the first interstage superheater (26). It is possible to maintain a certain degree of wetness in the steam at the inlet of the interstage superheater (26) by means of a by-pass pipe fitted with a valve (29). In this particular example, the pipes (6, 7 and 8) fitted with shut-off valves (10, 11 and 12), respectively, branch off between the superheater section (2) and the final superheater section (9). The first of these branch pipes again leads directly into the first interstage superheater (26). The pipe (7) fitted with the valve (11) makes it possible to couple the two interstage superheaters (26 and 27) of different pressure stages in parallel during the starting-up operation. The pipe (8) again leads to the water separator (40). If necessary, colder working fluid may be injected at the point (15) for cooling purposes, upstream of the separator (40). Valves (32 and 33), which are fitted into return pipes leading to the condenser or to the starting tank, serve the purpose of drawing off the working fluid utilised for cooling. The valves (31 and 34) preceded by the second interstage superheater (27) serve the same purpose. A valve (30) fitted in a by-pass pipe, in the vicinity of which valve an injection cooler (35) may also be provided, makes it possible to connect the two interstage superheaters (26 and 27) in series. The valve (13) is controlled by means of a temperature pick-off (20) and a pressure pick-up (22). These valves are operated in such a manner that they open at a predetermined temperature and close at a predetermined pressure. *British Patent No.* 877,706 *issued to Sulzer Frères, S.A. Complete specification published September 20th,* 1961.

Figs. 10 (right) and 11 (below). British Patent No. 877,748.





Heat transfer system

This invention relates to a heat transfer system of the kind comprising at least two media which at least partially flow in opposite directions. The first medium which releases heat has an entry temperature which is at least approximately constant, and its flow velocity is altered according to the quantity of heat this medium is to supply in such a manner that its outlet temperature also remains at least approximately constant. The second medium which absorbs the heat is a working medium which is vaporised and superheated at the pressures and temperatures prevailing in the heat transfer system. Such heat transfer systems are utilised in nuclear power plants, for example. In such a case the medium releasing heat is the reactor coolant, which is usually gaseous. Its temperatures at the inlet and outlet of the heat transfer system are kept constant by means of a regulating system. Owing to reasons connected with the reactor, these temperatures lie within a range in which appreciable heat radiation no longer occurs and practically all the heat in the heat transfer system is transferred by means of convection. The changes in the quantity of heat to be transferred, which are caused by changes in output, are produced by altering the velocity of circulation of the reactor coolant. Owing to the reduced production of vapour (steam

is the usual case where the working medium is water) the flow velocity of the working medium simultaneously also diminishes. This produces the result that according to the quantity of heat transferred, the point at which vaporisation of the working medium ceases in the transfer system is displaced, this displacement being downstream relative to the direction of flow of the working medium in the case of falling load, in the usual countercurrent system. For various reasons, which may be of a constructive nature for example, or where a liquid separator is to be fitted, it is of interest to fix the point at which vaporisation ends, that is to say, the point in the flow of the working medium at which the vaporisation process is completed, or to keep its displacement within desirable limits. Referring to Fig. 10, the heat transfer system (S) of a nuclear power plant transfers the heat generated in the nuclear reactor (R) to a working medium which drives a turbine (T). To this end, a first gaseous medium serving as a heat carrier is conveyed through the circuit (G) in the direction of the arrows shown. In doing so it absorbs heat from the nuclear reactor (R), conveys this heat into the heat transfer system (S), leaves some of its heat behind in the system and then returns into the nuclear reactor (R), in which it again absorbs heat. A second medium utilised as the working medium of the turbine (T) circulates in the circuit (M) in the direction of the arrows. A substance is used as the second medium which is vaporised and superheated at the pressure and temperature prevailing in the heat transfer system. Water is often a suitable medium. From the heat transfer system (S), superheated steam enters the turbine (T) which, after expansion and in most cases already as wet steam, enters into the condenser (C) and is then again introduced in the form of condensate into the heat transfer system (S) by means of a feed pump (E). Fig. 11 shows the heat transfer system (S) in more detail. The liquid working medium is delivered by the feed pump (E) through a restrictor (1) and into the first heat transfer section (*I*) and thence into a heat transfer section (*II*) immediately preceding its outlet. After the heat transfer section (*II*), the working medium flows through a liquid separator (3) and a restrictor (4) and is fed into a heat transfer section (*III*). After the heat transfer section (*III*), the working medium flows consecutively through heat transfer sections (*IV* and *V*) and to the turbine. A temperature pick-off (5) is provided downstream of the heat transfer section (*V*) at the outlet from the heat transfer system. A transmitting device (6) associated with the temperature pick-off (5) transmits a signal corresponding to the temperature to a servo motor (7) which actuates a valve (8), which in turn controls the supply of liquid working medium from the feed pump (E) through a line (9) and to an injector (10) located between the heat transfer sections (IV and V). The restrictor (4) and the temperature pick-off (2) are associated with devices (11 and 12) which transmit signals corresponding to the measured pressure and temperature, respectively, to a regulator (13), which in its turn acts on a control circuit formed by the restrictor (1), the measuring element (14) of the latter, a regulator (15), and a device (151) which regulates the rotational speed of the feed pump (E), thereby determining the quantity of working medium fed in per unit of time. The heat transfer sections (I to V) are housed in a passage (K) in the sequence *I, III, II, IV, V*, the reactor coolant circuit (G) passing through the said passage in the direction shown by the arrows. Two temperature pick-offs (16 and 17) are provided in the passage (K) in order to measure the inlet and outlet temperatures of the reactor coolant. The results of these measurements are transmitted to a regulating system, which is not illustrated, in the form of signals transmitted by devices (18 and 19), this regulating system influencing the speed of circulation of the reactor coolant. The liquid space of the liquid separator (3) is connected to the feed pump (E) by means of a valve (20) and the pipe (21). The valve (20) is adjusted by means of a regulator (22) according to the quantity of liquid present in the separator (3) and signalled by means of a measuring element (23). Some of the liquid present in the separator may by means of a valve (24) be fed to a measuring point where its content of non-volatilisable substances or their radioactivity is checked, and may by means of the said valve also be removed from the circuit or, after any purification that may be required, be returned to the circuit. *British Patent No.* 877,748 *issued to Sulzer Frères, S.A. Complete specification published September 20th,* 1961.

A new company, **G.E.C. (Engineering) Ltd.,** has been formed to take over and develop the engineering activities of **The General Electric Co. Ltd.** This is in accordance with the new policy of the G.E.C. to form its manufacturing groups into subsidiary companies. The manufacturing resources of the new company comprise the Electrical Engineering Works at Witton, Birmingham, and the Mechanical Engineering Works at Erith, Kent. The total number of employees exceeds 15,000. The Board of Directors of the new company will operate from headquarters in London, and negotiations for the acquisition of suitable premises are at present in progress. The following appointments have been made to the Board: chairman and managing director, **R. N. Millar**; director and general manager (Witton Works), **Mr. T. H. Kelsey**; director and general manager (Erith Works), **Dr. K. J. Wootton**; commercial director, **Mr. C. J. O. Garrard**; financial director, **Mr. E. Nicholson**; development director, **Dr. H. K. Cameron**; production director, **Mr. G. M. F. Donnelly**; personnel director (and assistant general manager, Witton Works), **Mr. W. D. Morton**; secretary, **Mr. J. E. Thomas.** The two members of the Board new to the G.E.C. organisation are Mr. Donnelly and Mr. Nicholson. Mr. Donnelly will join the new company on January 1st, 1962, when he will relinquish his appointment as general manager of British Northrop Ltd. Mr. Nicholson, whose appointment to the Engineering Group was announced in September, was formerly a deputy director of the Production Group of the U.K. Atomic Energy Authority. Two further appointments of importance to the new company are **Mr. D. W. T. Angwin,** previously chief resident engineer, Hunterston Nuclear Power Station, who now becomes assistant general manager, Erith Works; and **Mr. J. C. Morris,** previously commercial manager, United Power Co. Ltd., Erith, who now becomes commercial manager, export projects. It is stated that both these appointments are effective from January 1st, 1962, also.

Contracts recently placed with **W. H. Allen Sons & Co. Ltd.** by the Southend Waterworks Company included one valued at approximately £38,000 which covers pumping plant for the Nevendon Booster Station. Five 12-in./10-in. horizontal-spindle, double-suction pumps are to be supplied, driven by Laurence Scott variable-speed motors, for supplying more water into various zones of the Waterworks Company area. Two other contracts totalling approximately £103,000 have been placed. The first covers raw-water pumps by which four 12-in. suspended mixed-flow pumps will be obtained. The other is for treated-water pumps which will comprise three 14-in./12-in. horizontal-spindle, two-stage, double-suction units, driven by 400-h.p. Laurence Scott variable-speed motors. (*W. H. Allen Sons & Co. Ltd., Bedford.*)

NOTES *Personal* AND *Industrial*

Sir Eric Jones, K.C.M.G., C.B., C.B.E., who, from 1952 until last year, was director of Government Communications Headquarters at the Foreign Office, has joined Associated Electrical Industries Ltd. as a consultant.

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Mr. G. B. R. Feilden, M.A., M.I.Mech.E., F.R.S., has resigned his present directorships in order to join the board of Davy-Ashmore Ltd. as technical director on December 4th. Mr. Feilden will be based at the Group's London headquarters at 15, Portland Place, W.1, and will also be joining the boards of the principal operating companies of the Davy-Ashmore Group.

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Mr. L. Barton, A.M.I.H.V.E.; **Mr. A. B. Crompton,** A.M.I.H.V.E.; **Mr. G. L. Jaques,** A.M.I.Mech.E., A.M.I.H.V.E.; and **Mr. L. Winstanley,** A.M.I.Mech.E., A.M.I.H.V.E., have been appointed assistant directors of Matthews and Yates Limited, Cyclone Works, Swinton, Manchester, designers and manufacturers of fans and air-treatment plant. Messrs. Barton, Crompton and Winstanley are engineering executives at the head office in Manchester, and Mr. Jaques is employed in a similar capacity in the London office at 135, Rye Lane, S.E.15.

* * *

A new director has been appointed to the board of Geo. Salter & Co. Ltd., of West Bromwich, to take charge of the company's manufacturing interests overseas. He is **Mr. G. P. Bache,** younger brother of the company chairman, **Mr. R. Philip S. Bache.** Mr. G. P. Bache has recently returned to this country from Australia where he was, for nine years, managing director of the Salter spring balance and spring factories.

* * *

Associated Electrical Industries Ltd. announced the following engineering appointments in its Turbine-Generator Division:—**Mr. J. S. Hall,** B.Sc. Tech., A.M.I.Mech.E., divisional assistant chief mechanical engineer (turbines); **Mr. J. V. Bigg,** M.A., A.M.I.Mech.E., A.M.I.Mar.E., divisional assistant chief mechanical engineer (auxiliary apparatus) and chief engineer, general engineering department; **Mr. D. M. Smith,** F.R.S., M.I.Mech.E., F.R.Ae.S., consulting mechanical engineer; **Mr. D. F. Shannon,** Ph.D., M.I.Mech.E., chief engineer, mechanical experimental development and gearing; **Mr. F. R. Harris,** B.Sc.(Eng.), A.M.I.Mech.E., chief engineer, advance turbine development, and chief engineer gas-turbine engineering department; **Mr. J. C. London,** B.Sc., M.I.Mech.E., A.M.Inst.C.E., chief engineer, large steam turbines, and **Mr. A. A. Garson,** M.A. (Cantab.), A.M.I.Mech.E., chief engineer, medium steam turbines.

Durapipe & Fittings Ltd., thermoplastic pipe and fittings manufacturers, announce the appointment of **Mr. D. C. B. Chandler** as United Kingdom sales manager.

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Mr. R. L. H. Damerham, technical director of Durapipe & Fittings Ltd., has been elected chairman of the new Thermoplastic Pipe and Fittings Group of the British Plastics Federation.

* * *

Mr. J. E. Bailey, B.A., Grad.I.Mech.E., has been appointed assistant superintendent, Petershill Works, AEI Turbine-Generator Division. Mr. Bailey joined Metropolitan-Vickers Electrical Co. Ltd. in 1953 and after completion of his college apprenticeship at the Trafford Park Works, became cost reduction engineer at the Petershill Works. He returned to the Trafford Park Works in 1957 as Production Engineer, Small Turbine Department and was appointed divisional production engineer of the Turbine-Generator Division in 1958.

* * *

Associated Electrical Industries Ltd. announce two new appointments in the Heavy Plant Division. **Mr. J. A. Garrod,** M.Eng., A.M.I.E.E., becomes engineer-in-charge, Control Equipments, Plant Applications Engineering Department, while **Mr. G. H. Sutton,** Assoc.I.E.E., is appointed commercial engineer-in-charge, Rolling Mills, Large Electrical Machine Sales.

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Dewhurst & Partner Ltd., Hounslow, manufacturers of automatic electric control equipment, announce the appointment of **Mr. E. Trattles** as Western Area sales manager, to operate from the company's Gloucester office, at 56-58, Barton Street, Gloucester.

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The British Engineers' Association states that **Mr. E. N. Griffith,** C.I.B.A.E., chairman of Rotary Hoes Ltd., has been elected President for the ensuing year. **Mr. K. M. Leach,** B.Sc., A.M.I.Mech.E., director of Serck Ltd., and of Audco Ltd., has been elected vice-president.

* * *

The British Iron and Steel Federation announces the following appointments: **Mr. E. W. Senior** to be director of the Federation; **Mr. J. B. Cowper** to be managing director of British Iron and Steel Corporation Ltd., in addition to his present post of financial director of the Federation; **Mr. J. Driscoll** to be assistant director (economics); **Mr. L. J. Gollop** to be assistant director (statistics); **Mr. B. S. Keeling** to be assistant director (training); **Mr. A. H. Mortimer** to be assistant director (commercial), and **Mr. K. Donohue** to be secretary of the Federation.

Mr. C. W. Page has been appointed sales manager of the Industrial Division of Castrol Industrial Ltd. This is a newly-created post. For the past three years, Mr. Page has been a departmental sales manager within the Industrial Division.

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Mr. N. R. Livesley has been appointed assistant superintendent, X-ray Department, at the Motherwell Works of Associated Electrical Industries Ltd. It was in 1950 that he was transferred from Trafford Park Works to the Motherwell Works as foreman of the X-ray Feeder Dept., subsequently becoming general foreman, of the X-ray Department.

* * *

Commander A. B. Dickie, A.M.I.Mech.E., M.I.Mar.E., and **Mr. J. H. Stimson** have been appointed assistant directors of Newman Hender & Co. Ltd., Woodchester, Stroud, Glos., manufacturers of industrial valves and allied products. Commander Dickie, head of the Newman Hender Group Research and Development division will continue as director of that division. Mr. Stimson, who has been deputy to the sales director, also will continue in his present field, as assistant director of sales.

* * *

The Harland Engineering Co. Ltd. announces that its Canadian operations, previously in the hands of Bepco Canada Ltd., were taken over from November 1st, 1961, by **The Harland Engineering Company of Canada Ltd.,** with Head Office in Montreal. **Mr. J. A. Cumming** has been appointed general manager and director. This development is aimed at the more active sales promotion of Harland hydraulic and electrical products, particularly new developments in drives for the paper and metals processing industries and at strengthening the specialist engineering service available to the Company's many customers throughout the Canadian continent.

* * *

Flexibox Ltd., Trafford Park, Manchester 17, have recently occupied a new additional office block. Although the original block was built less than five years ago, the move was necessitated by the unforeseen growth in the company's business.

* * *

Aiton and Co. Ltd., Derby, has been awarded a contract from the Central Electricity Generating Board for high-pressure steam, re-heat and feed piping for the first supercritical steam pressure installation planned to be commissioned by the Board in the "C" station at Drakelow, Burton-on-Trent. The design conditions for the main steam piping are 4,015 lb. per sq. in. and 1,110 deg. F. in austenitic stainless-steel pipes of 8 in. internal diameter, 2½ in. thick.